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The Algol-type eclipsing binary TZ Eridani: BV photometry and search for pulsations and tertiary component

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Abstract

CCD photometric observations of the Algol-type eclipsing binary TZ Eri have been obtained in B and V filters during 26 nights from December 2007 to February 2008 at the Athens University Observatory. The light curves are analyzed with the Wilson-Devinney code, new geometric and photometric elements are derived, a time series analysis of the observations is applied and a multiperiodic behavior is also discussed. The presence of a third light in the system is considered and our results are compared with those of the O-C analysis for a third body in the system, given by Zasche et al. (2008).

Individual Objects: TZ Eri

Light Curve Analysis and Pulsational Behaviour

The light curves were analyzed with the PHOEBE 0.29D software (Prša & Zwitter 2005) which uses the 2003 version of the Wilson-Devinney code running in MODE 5. The temperature of the primary component and the mass ratio of the system were set as free parameters, using the model of Barblan (1998) as the initial solution while the temperature of the secondary component was fixed in the value derived from the B-V index of the same paper. The contribution of a third light was also considered and the albedo of the secondary component, A_2 was set on 1, with respect to the reflection effect due to the large temperature difference of the two components. The albedo A_1 of the primary component, the gravity darkening coefficients, g_1 and g_2 and the limb darkening coefficients, x_1 and x_2 were set to the theoretical values. The synthetic and observed light curves are shown in Figure 1 (left part), while the derived parameters from the solution are listed in Table 1. The frequency analysis was performed using the data points well outside the primary eclipse, which were substracted from the theoretical light curves using the software PERIOD04 (Lenz & Breger 2005). The results of the frequency analysis are listed in Table 1. Fig. 1 (upper right part) shows the periodogram of the frequencies which are well inside in the range of δ Sct type pulsations. Solution in both filters indicates that the most significant frequency f_1 is about 18.7 c/d while multiple other lower frequencies appear in the periodograms, which are mainly the result of the non-optimal substraction of the binary model and the variations of nightly mean levels not pointed out in the figure. We did not find any reasonable frequency values with amplitudes larger than 2 mmag after prewhitening these frequencies in each filter. Agreement between the solution and the residuals on the longest day is also shown in Fig. 1 (lower right part).

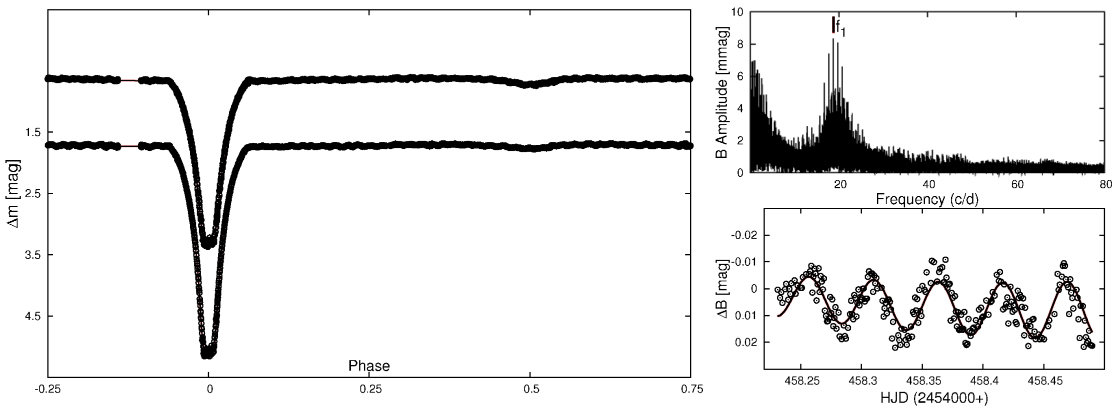

Figure 1: Observational and theoretical light curves (left part) and the periodogram and the frequency analysis on the longest day of observations between the phases 0.405-0.515 (right part).

Table 1: Solution of the light curve and frequency analysis.

Light curve parameters		Pulsational	parameters		
Parameter	Value	Filter	Freq. (c/d)	Amp. (mmag)	S/N
i (degrees)	87.69(7)				
q	0.1773(5)				
T_1, T_2(K)	9307(20), 4562[a]	B	18.7174	8.3	18.2
Ω_1, Ω_2	6.323(12), 2.175		19.6126	3.2	6.7
$[L_1/L_T]_B$, $[L_1/L_T]_V$	0.9418(14), 0.8892(13)				
$[L_2/L_T]_B$, $[L_1/L_T]_V$	0.0529, 0.0990	V	18.7177	7.3	11.7
$[L_3/L_T]_B$, $[L_1/L_T]_V$	0.0053(8), 0.0118(9)		20.6134	2.2	4.1
χ^2	0.499967				

[a] *adopted*
$L_T = L_1 + L_2 + L_3$

Discussion and Conclusions

The present light curve solution shows that TZ Eri is a semi-detached system with the secondary component filling its Roche Lobe. The primary component pulsates with a frequency of 18.7 c/d showing pulsational characteristics very similar to those of a δ Sct star (5-80 c/d, Breger 2000). The contribution of a third light in the system was found to be less than 1% of the total light. The O-C study of the system, showed by Zasche et al. (2008), strongly supports the existence of a tertiary component ($M_{3,min} \sim 1.3 M_{\odot}$) revolving around the eclipsing binary, where mass transfer occurs between the two components. These two independent methods (the O-C analysis and the light curve analysis) come into agreement for the mass exchange between the two components, but not for the existence of the tertiary one. The photometric solution depends on the light contribution of the third body, while the O-C analysis depends only on the period changes. A low luminosity star, having enough mass to affect the binary's orbit might be the connection key between these two methods of analysis. Follow-up observations in other than optical wavelengths are necessary to study the existence and the nature of the additional component.

References

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