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Period Variation Analysis of EZ HYDRAE

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Abstract

In this paper, the period variation of the W UMa–type eclipsing binary EZ Hya has been investigated using all published times of minimum light of the system. The *O-C* (Observed minus Calculated) diagram of the system can be represented with a sinusoidal character change. This change includes one maxima and two minima with in approximately 55000 orbital period of the system. The sinusoidal cycle in the diagram is given the possibility of the light - time effect caused by the third body. Using the *O-C* variation the third body orbit parameters were determined. The minimal mass of the third body is about 1.21 $M_{\odot}$, and its orbital period about 52 year. The cycle - variation analysis gives a value of 0.047 ± 0.003 day as the semi amplitude of the light - travel time effect and 0.23 ± 0.13 as the orbital eccentricity of the third body. The semi - major axis of the orbit of the third body is determined to be 8.2 ± 0.5 AU.

Keywords: EZ Hya, period variation, light - time effect

EZ HYDRAE Sisteminin Yörünge Değişim Analizi

Özet

Bu çalışmada, W UMa tipi Ez Hya örten çift sistemin yayınlanmış tüm minimum zamanları kullanılarak yörünge değişimi incelendi. Sistemin *O-C* (Gözlenen eksi Hesaplanan) diyagramı sinüsoidal karakterli bir değişim göstermektedir. Bu değişim, sistemin yaklaşık 55000 çevriminde iki minimum ve bir maksimum içermektedir. Sistemin döneminde görülen çevrimsel değişimin nedeni, sisteme bağlı muhtemel bir üçüncü cismin meydana getirdiği ışık – zaman etkisidir. *O-C* değişiminden üçüncü cismin yörünge parametreleri belirlendi. Üçüncü cisim adayının kütlesi yaklaşık 1.21 $M_{\odot}$, yörünge periyodu yaklaşık 52 yıl olarak hesaplandı. Işık – zaman etkisi sonucu oluşan çevrimsel değişimin yarı genliği 0.047 ± 0.003 gün, üçüncü cismin yörünge basıklığı 0.23 ± 0.13 ve üçüncü cismin yörüngesinin yarı - büyük eksen uzunluğu ise 8.2 ± 0.5 AB olarak hesaplandı.

Anahtar Sözcükler: EZ Hya, dönem değişimi, ışık – zaman etkisi

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1. Introduction

EZ Hya (BD-13.2854, TYC 5471-566-1, V_{max}= 10.48 mag, spectral type F9 V (SIMBAD database)) is a W UMa type eclipsing binary with an orbital period of 0.449751 days. It was identified as a variable star by Hoffmeister (1931). The spectral type of this system is given as G5 by Mac Donald (1964) and F9 by Won Gotz and Wenzel (1966). EZ Hya was observed photometrically by various authors (Bookmyer 1974; McFarlane and Hilditch 1987; Lipari and Sistero 1987) and spectroscopically by King and Hilditch (1984). Recently, Yang (2004) published the absolute parameters for EZ Hya: R_1 = 1.54 $R_\odot$, M_1 = 1.37 $M_\odot$, R_2 = 0.85 $R_\odot$, M_2 = 0.35 $M_\odot$. Lipari and Sistero (1987) presented the parabolic ephemeris with a period decrease of 0.84 x 10^{-9} days cycle^{-1}. A detailed period study of EZ Hya was published by Yang (2004), who presented the parameters of an unseen third body in the system. He found a period of 11297 days (30.9 yr) with 0.57 $M_\odot$ for the third body masses.

2. *O* - *C* diagram analysis

All available minima times for EZ Hya were collected from different previously reported sources in the literature. Minima times contain a data set of 20 visual, 30 photographic, 3 photoelectric and 16 CCD minima times. The *O-C* residuals were computed using the following linear light elements given by Yang et al. (2004):

$$\text{Min. I} = \text{HJD } 2453055.2413 + 0^d.44974752 \times E.$$

The *O-C* diagram represents a continuous sinus oscillatory variation with one maxima and two minima superimposed on the linear variation. Assuming that the most likely cause of the cyclic variation in the *O–C* diagram could be light travel time effect (LTTE) due to an unseen third body, the following LTTE equation, as given by Irwin (1952, 1959), was fitted to the *O–C* residuals using the computer program written by Zasche et al. (2009)

$$(O\text{-}C) = \left[T_0 + P_{orb} \times E + \frac{A}{\sqrt{1-e^2 cos^2\omega'}}\left\{\frac{1-e'^2}{1+e' cos v'}\sin(v'+\omega') + e'\sin\omega'\right\}\right] \quad \textbf{Eq.1}$$

where e', ω', and v' are the eccentricity, longitude of the periastron and true anomaly of the third - body orbit, respectively. The observed semi-amplitude (*A)* of the ligh-travel time curve (in days) is Eq.2 :

$$A = \frac{a'_{12}\sin i'}{173.15}\sqrt{1-e^2 cos^2\omega'} \quad \textbf{Eq.2}$$

The solution parameters and their standard errors, which were used to obtain the theoretical *O-C* curve, are provided in Table 1. The observational points and theoretical best fit curve are plotted in Figure 1.

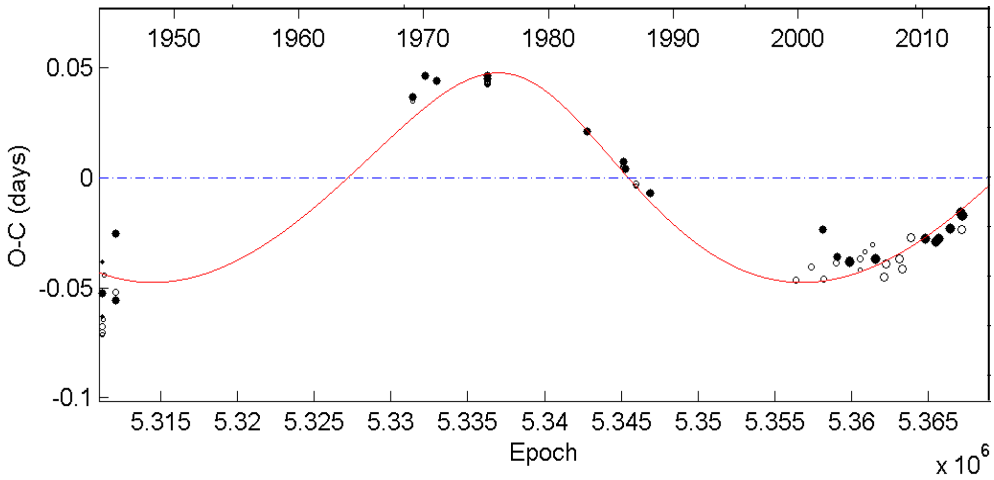

Figure 1. The *O* - *C* diagram for EZ Hya obtained with the parameters in Table 1. The open symbols are for the secondary and the filled symbols are for the primary.

Table 1. The hypotetical third body orbit parameters of EZ Hya.

Parametreler	**Unit**	**Present study**
T	HJD	2442453.8178400 ± 1.3941081
P	day	0.44975078 ± 0.00000026
T_0	HJD	2443996.738
A	day	0.047 ± 0 003
P_{12}	year	52.06 ± 2.59
e'		0.23 ± 0.13
ω'	o	115 ± 71
a'_{12}sin i	AU	8.28 ± 0.52
f(m)	$M_\odot$	0.20
M_3 (90)	$M_\odot$	1.21 ± 0.01
M_3 (60)	$M_\odot$	1.49 ± 0 01
M_3 (30)	$M_\odot$	3.63 ± 0.02

3. Conclusion

In this paper, we presented the period variation analysis of the W UMa–type contact binary EZ Hya. For this, the *O- C* diagram of the systems formed from all available times of eclipse minima were used. The character of the *O–C* variation of the system had a periodic shape. The *O–C* data of EZ Hya was analyzed an unseen third body around the eclipsing binary, represented by tilted sinusoidal changes in *O–C* diagram. According to *O-C* analysis, the eclipsing pair should have an eccentric orbit ($e' \approx 0.23 \pm 0.13$) around the mass center of the triple system with a period of 52.06 ± 2.59 years. For this orbit, the projected semi-major axis would be about 8.28 ± 0.52 AU. The minimal mass value of the unseen component was found to be 1.21 ± 0.01 $M_\odot$.

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