



Orbital Period Change of the Binary Star System V829 Aql

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Abstract: A variable star, V829 Aql, is considered one of the binary stars providing invaluable insights into the process of stellar evolution. The purpose of this research study is to calculate the orbital period change of the binary star system V829 Aql using a telescope at the Regional Observatory for the Public, Songkhla, National Astronomical Research Institute of Thailand (Public Organization). Images in the *B* and *V* wavelength range will be taken on the night of July 1-2, 2021, from 9:00 p.m. to 5:00 a.m., and subsequently examined. It was discovered that the brightness value pattern adhered to an equation (relationship): the orbital period equals the lowest brightness when it does. The orbital period change is growing, as indicated by the equation $O-C = (4.82878 \times 10^{-13}) \text{ Epoch}^2 - (1.5221 \times 10^{-7}) \text{ Epoch} - 0.01052$, which gives a rate of change in orbital period of 1.05×10^{-4} seconds/year. This means that stars continue to separate, which explains the evolution of the TRO theory.

Keywords: V829 Aql; orbital period change; TRO

1. Introduction

The Moon, Mars, Mercury, Jupiter, Venus, and Saturn are the only six celestial objects in the night sky that are not stars. Binary stars, or systems of two stars with the same barycenter, make up the majority of stars in our sky. Astronomers learned about the evolution of stars by analyzing data from binary star systems. Periodically brilliant binary systems are known as eclipsing binaries [1]. When one is behind the other, their light curves are smaller. Some of their attributes were calculated using the light curve and the photometry approach. The V829 Aql was reported to be a pulsating star in 1997 [1] and 1998 [2]. In the present time, according to the SIMBAD Astronomical Database [3], the V829 Aql is an eclipsing binary star with R.A. 19 h 46 m 57.282 s and Dec. +03° 30' 28.482". The duration of the orbit is 0.211401 days [4]. To understand the evolution, we examine the period changes of V829 Aql in this paper. The binary is compatible with the Thermal Relaxation Oscillation (TRO) theory if the change is growing [5]. On the other hand, the binary is equivalent to the Angular Momentum Loss (AML) theory if the period change is decreasing [6-7].

This study's goal is to examine how the V829 Aql period has changed. The light curve used in this paper comes from photometric analysis in the *B* and *V* wavelength bands.

2. Materials and Methods

On July 1, 2021, UT, the V829 Aql was observed at the Regional Observatory for the Public located in Songkhla, Thailand. Utilized was the 0.7-meter reflecting telescope and CCD equipped with the UBV system's blue (*B*) and visual (*V*) filters. The observation was conducted under a nearly clear sky with partial cloud cover. V829 Aql was observed with *B* and *V* filters, with an exposure time of 30 seconds per frame. A total of 129 images were obtained in the *B* filter and 118 images in the *V* filter. The example of the V829 Aql photograph and the fundamental data are shown in Figure 1 and Table 1, respectively.

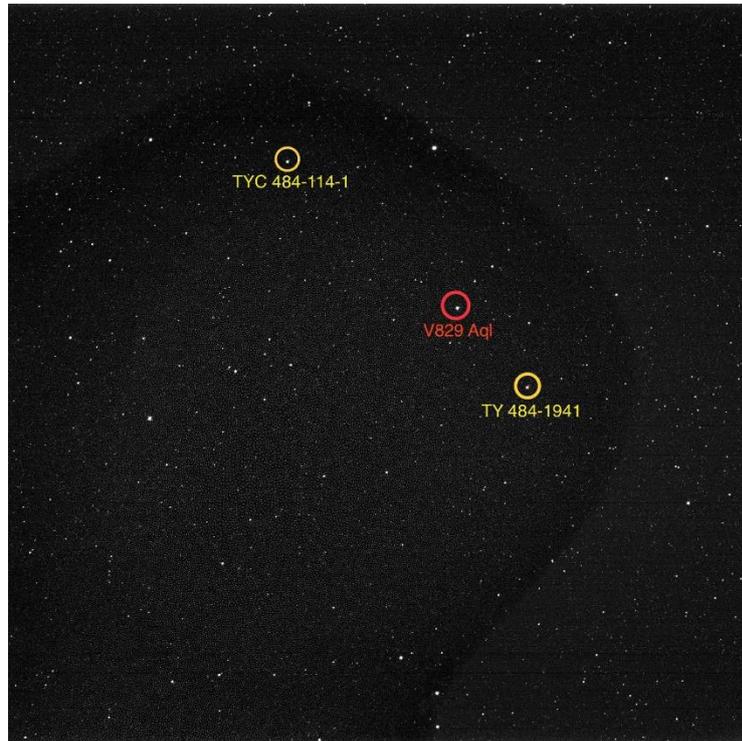


Figure 1. Photograph of the V829 Aql

Table 1. Information on the V829 Aql

Star	R.A. (h m s)	Dec (° ' ")	Magnitude <i>V</i>
V829 Aql	19 46 57.281	+03 30 28.481	10.06
TYC 484-194-1 (comparison)	19 46 51.094	+03 26 50.201	10.83
TYC 484-114-1 (check)	19 47 14.563	+03 37 37.662	10.77

The photometric analysis was performed using MaxIm DL6 software [8]. As the first step of noise reduction, the bias and dark frames were subtracted, and the flat-field correction was applied [9], as expressed in equation (1). Subsequently, the stellar flux was analyzed, and the results are presented in Figure 2.

$$\text{Reduction Image} = \frac{\text{Raw} - \text{bias} - \text{dark}}{\text{Flat}} \quad (1)$$

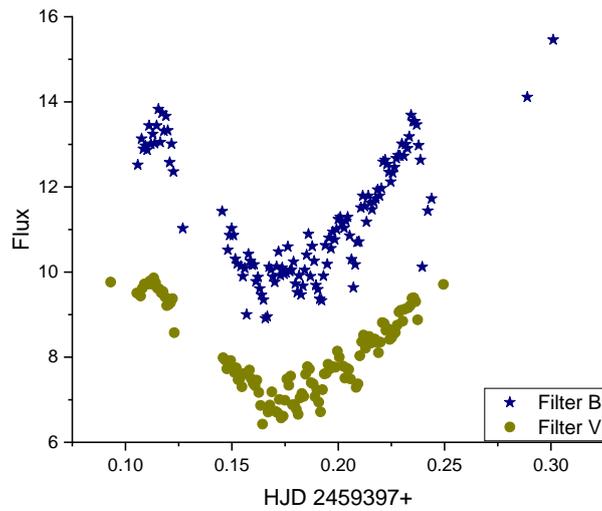


Figure 2. The light curve of V829 Aql in the B (blue dots) and V (green dots) filter.

3. Results and Discussion

The times of minimum light computation in this work were obtained from ordinary differential equation (ODE) theory [10]. The minimum-light areas in the B and V filters were selected for calculation, as shown in Figures 3(a) and 3(b), respectively.

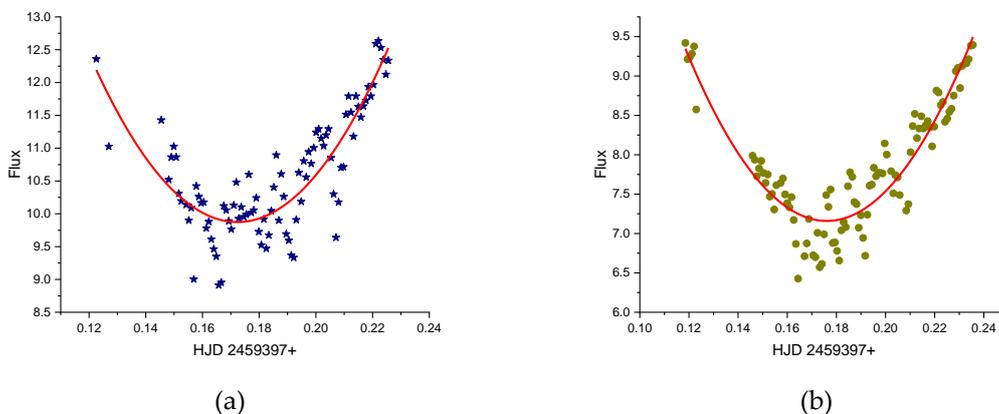


Figure 3. The ODE fits show the minimum eclipse depths obtained from the observation with B (a) and V (b) filters, respectively.

To determine the O-C data for all the moments of minimum light, Bob Nelson's database of eclipsing binary O-C data was used [5].

$$\text{HJD Min} = 2443061.404 + 0.2114012E \tag{2}$$

The times of V829 Aql's minimum brightness were determined throughout the investigation, as shown in Table 2.

Table 2. The O-C data of V829 Aql

Time of Minimum	Epoch	O-C	Source
2429794.379	-107407.5	0.011389	AC 39.5
2429823.283	-107270.5	-0.0465754	AC 39.5
2429875.167	-107025.5	0.0441306	AC 39.5
2430929.277	-102039	0.0020468	AC 39.5
2430939.267	-101991.5	-0.0495102	AC 39.5
2430995.148	-101727.5	0.021573	AC 39.5
2431236.367	-100586.5	0.0318038	AC 39.5
2431265.344	-100449.5	0.0468394	AC 39.5
2431287.315	-100345.5	0.0321146	AC 39.5
2442621.464	-46731	0.0114772	BBS 34
2442632.34	-46679.5	0.0003154	BBS 34
2442633.5	-46674	-0.0023912	BBS 34
2442740.26	-46169	2.8E-06	BBS 34
2442993.382	-44971.5	-0.0309342	BBS 34
2443016.378	-44863	0.0280356	BBS 34
2443360.421	-43235.5	0.0155826	BBS 34
2443431.29	-42900	-0.04052	BBS 35
2443434.32	-42886	0.0298632	BBS 35
2444793.498	-36456.5	0.0038478	BBS 56
2444821.398	-36324.5	-0.0011106	BBS 56
2448127.371	-20686	-0.0257768	BBS 96
2448167.313	-20497	-0.0386036	BBS 96
2448534.308	-18761	-0.0360868	BBS 99
2449549.456	-13959	-0.0366492	BBS 107
2449600.339	-13718.5	0.0043622	BBS 107
2449933.493	-12142.5	-0.009929	BBS 110
2452500.442	0	0	vis
2453981.993	7008	0.0514904	VSB 45
2454297.54	8501	-0.0232012	BAVM 193
2455324.242	13357.5	0.007971	VSB 51
2455438.031	13896	-0.0417752	VSB 51
2459397.174	32624	-0.0205488	This work

The quadratic polynomial fitting method was used to fit the O-C data from this study, in combination with values from Bob Nelson and the AASVO database. The outcome is displayed in Figure 4.

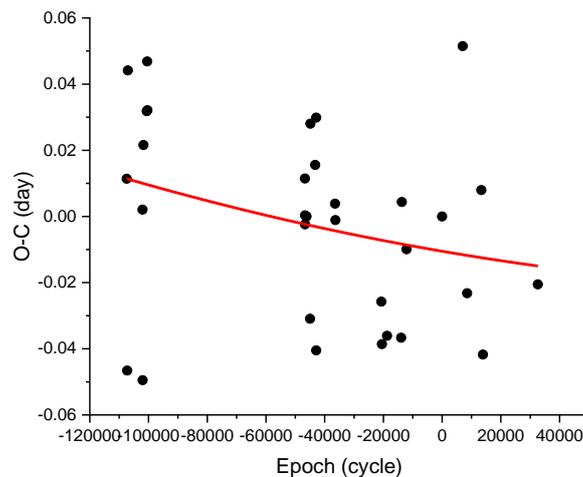


Figure 4. The $O-C$ diagram of V829 Aql.

The relevant equation for the quadratic fitting method in Figure 3 (red line) is as follows.

$$O-C = (4.82878 \times 10^{-13}) E^2 - (1.5221 \times 10^{-7}) E - 0.01052 \quad (3)$$

The value of dP/dE was obtained by comparing it with the $O-C$ quadratic equation (3) as follows:

$$dP/dE = 2 \times (4.82878 \times 10^{-13}) = 9.65756 \times 10^{-13} \text{ days/cycle} \quad (4)$$

The rate of increment in the V829 Aql period is $9.65756 (10^{-13} \text{ days/cycle})$ or $1.05 (10^{-4} \text{ seconds/year})$. The increase in the period indicated that, in accordance with Thermal Relaxation Oscillation (TRO), the distance between the stars had increased [11].

4. Conclusions

On July 1, 2021, UT, the eclipsing binary system V829 Aql was spotted at the Regional Observatory for the Public in Songkhla, Thailand, and photometry analysis was performed. The V829 Aql light curve indicated that HJD 2459397.1742 was the minimum light time of V829 Aql. The binary system V829 Aql's period change (dP/dE) is evident from both the diagram and the solution, and it is $2 \times (4.82878 \times 10^{-13})$ days/cycle or roughly 1.05×10^{-4} seconds/year. It indicates a greater separation between the two stars. Ultimately, the double stars will evolve align with the TRO theory. It explained that the binary star system will transfer its energy. In the condition that mass and angular momentum are conserved, the distance is far apart. That means the orbital period is increased. The steadily increasing orbital period indicates that the two stars are gradually moving farther apart.

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