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*Research article*

# The First Study of a Period Change of the V1851 Orion Eclipsing Binary System

**Warisa Pancharoen[1] and Wiraporn Maithong[2*]**

[1] Department of Physics and General Science, Faculty of Science and Technology, Phetchaburi Rajabhat, University, Phetchaburi, Thailand, 76000; warisa.pan@mail.pbru.ac.th
[2] Department of Physics and General Science, Faculty of Science and Technology, Chiang Mai Rajabhat University, Chiang Mai, Thailand, 50300; wiraporn_mai@cmru.ac.th
* Correspondence: E-mail: wiraporn_mai@cmru.ac.th

**Abstract**: V1851 Orion (V1851 Ori) is an eclipsing binary star which an orbital period of 0.27695 days. We use the 0.5 - meter reflecting telescope and CCD with the standard visual (*V*) and red (*R*) filters of the UBV system at the Regional Observatory for the Public, Chachoengsao, Thailand, to observe their light curve. The photometry method calculates the light curves construction and the time of minimum determination. In this work, the time minimum of V1851 Ori is HJD 2458105.0490. The period change is calculated using the *O-C* diagram and it is shown that the period of the V1851 Ori is decreasing which the rate of $2 \times (-6.75647 \times 10^{-12})$ day/cycle. That means the period reduces continuously by approximately $1.54 \times 10^{-3}$ seconds/year.

**Keywords**: V1851 Ori, Period Change, O-C Diagram.

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## 1. Introduction

Most stars in our sky are binary stars, the system of two stars that share the same barycenter. The information from the binary stars system made the astronomers know about the stars' evolution. Eclipsing binaries are binary systems that have their brightness in periodic. The light curve of them is lower when one is behind another.[1] The photometry technique was used to calculate some of their properties to contribute to the light curve. The V1851 Orion (V1851 Ori) is an eclipsing binary star which R.A 5 h 12 m 45 s and DEC +10 °15′ 11′′. The orbital period is 0.27695 days.[2] In this work, we study the period change of the V1861 Ori. The binary period change explains the evolution that if the change increases, the binary is consistent with the Thermal Relaxation Oscillation (TRO) theory.[3] On the other hand, if the period change decreases, the binary is synonymous with the Angular Momentum Loss (AML) theory. [4]

## 2. Materials and Methods

V1851 Ori was observed on 17 December 2017, UT at the Regional Observatory for the Public, Chachoengsao, Thailand. The 0.5 - meter reflecting telescope and CCD with the standard visual (*V*) and red (*R*) filters of the *UBV* system were used. The Comparison and the Check stars are TYC 702-2174-1 and HD 33720. The photometry was analyzed that the observational light curve of V1851 Ori in *V* and *R* wavelength bandwidth is shown in Figure 1. The times of minimum light were calculated from the selected data in the minimum light area in *V* and *R* filter. They were computed by differential equation theory that as shown in Figure 2 and Figure 3, respectively. The result was used in the $O-C$ diagram to calculate their period changes.

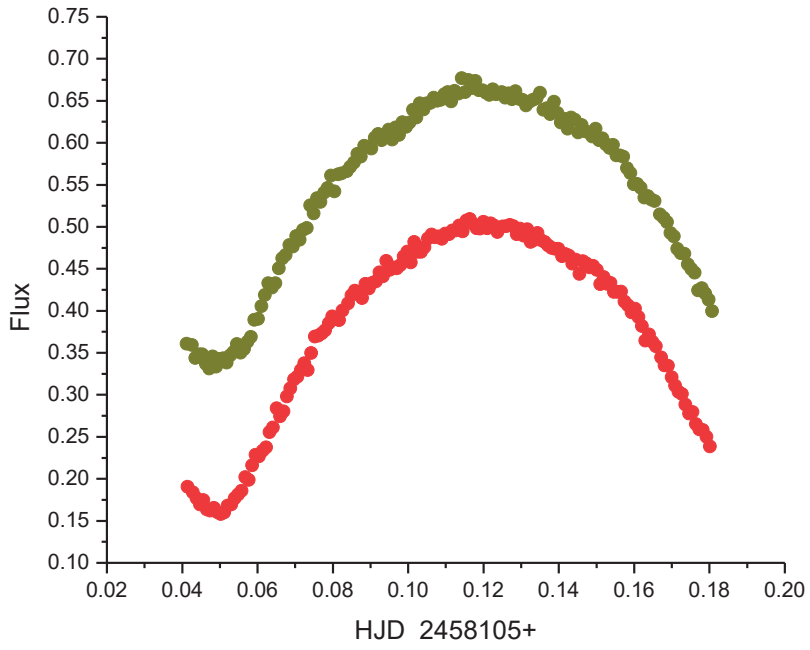


**Figure 1.** Light curve of the V1851 Ori in *V* and *R* filter.

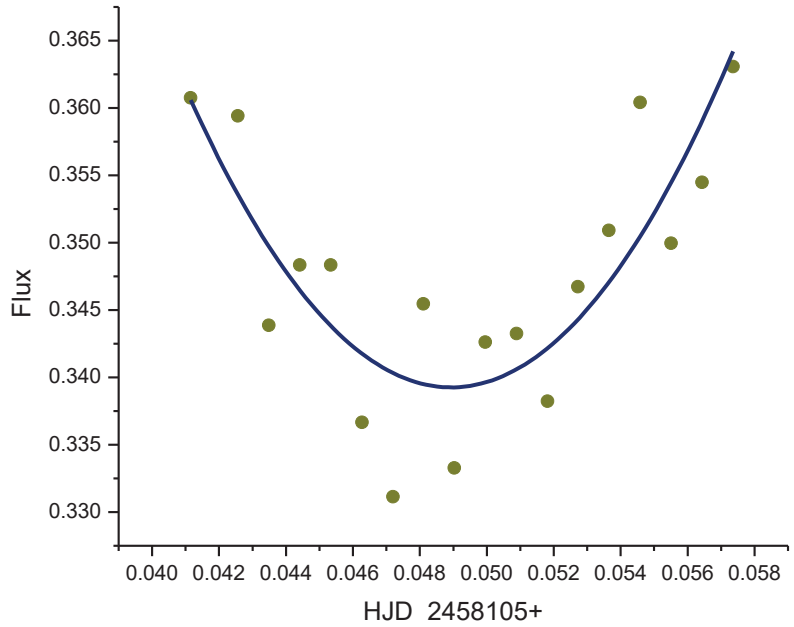


**Figure 2.** Light curve from the minimum light area of the V1851 Ori in the *V* filter.

The time of minimum light was calculated by differentiating the quadratic equation fitting that the slope is equal to zero. If the vertical axis is $y$ and the horizontal axis is $x$, the computation is as follow;

$$y = 352.0302x^2 - 34.45659x + 1.18241$$

$$\frac{dy}{dx} = 2(352.0302)x - 34.45659 = 0$$

$$x = 0.048940$$

So, the time of minimum light from the *V* filter is *HJD* 2458105 + 0.048940 = HDJ 2458105.048940. In the same way, the time of minimum light from the *V* filter was calculated that as follow;

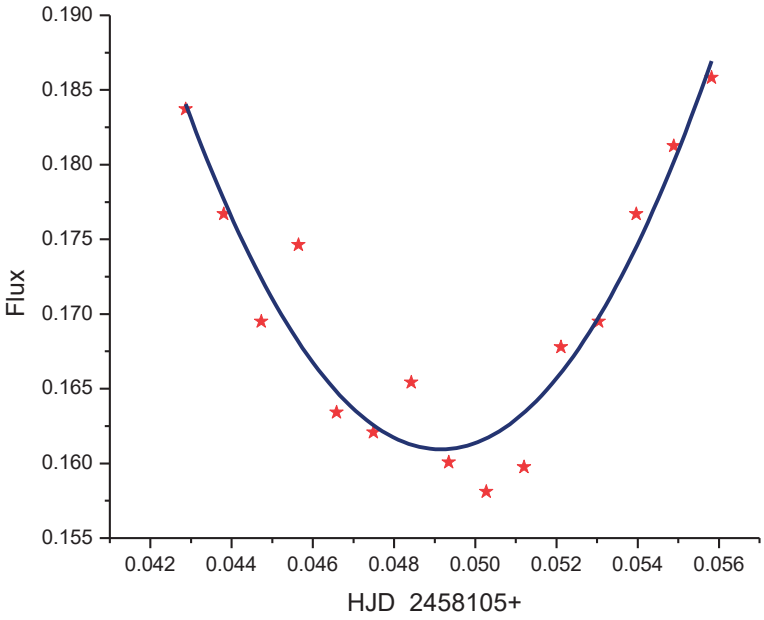


**Figure 3** Light curve from the minimum light area of the V1851 Ori in *R* filter.

$$y = 584.93803x^2 - 57.50182x + 1.57411$$

$$\frac{dy}{dx} = 2(584.93803)x - 57.50182$$

$$x = 0.049152$$

The time of minimum light from the *R* filter is *HDJ* 2458105.049152. Therefore, the average time of minimum light from the *V* and *R* filters is *HDJ* 2458105.0490.

## 3. Results and Discussion

The time of minimum light from the V1851 Ori light curve was determined and constructed the $O-C$ diagram. It derived from the linear ephemeris equation obtained from the Database of Eclipsing Binary $O-C$ Files by Bob Nelson, AAVSO [5] as follows:

$$HJD\ Min = 2452617.77 + 0.27695E \quad (1)$$

When *HJD Min* is the photoelectric times of the minimum light,
and *E* is the epochs of the minimum light.
In this observation, the light curves were calculated the times of minimum light and there $O-C$ in this work and from the pass as shown in Table 1.

**Table 1.** The $O-C$ values of the V1851 Ori.

| Time of Minimum | Epoch | $O-C$ | Source |
|---|---|---|---|
| 2452617.77 | 0 | 0 | TASS |
| 2452950.8087 | 1202.5 | 0.00633 | IBVS 5493 |
| 2452950.8087 | 1202.5 | 0.00633 | IBVS 5493 |
| 2454066.3455 | 5230.5 | -0.0115 | IBVS 5781 |
| 2454066.4841 | 5231 | -0.0113 | IBVS 5781 |
| 2454066.6197 | 5231.5 | -0.0142 | IBVS 5781 |
| 2454083.3803 | 5292 | -0.0091 | IBVS 5781 |
| 2454083.517 | 5292.5 | -0.0109 | IBVS 5781 |
| 2454083.6523 | 5293 | -0.014 | IBVS 5781 |
| 2454085.3181 | 5299 | -0.0099 | IBVS 5781 |
| 2454085.4516 | 5299.5 | -0.0149 | IBVS 5781 |
| 2454085.5966 | 5300 | -0.0084 | IBVS 5781 |
| 2454090.3 | 5317 | -0.0131 | IBVS 5781 |
| 2454090.4428 | 5317.5 | -0.0088 | IBVS 5781 |
| 2454090.5764 | 5318 | -0.0137 | IBVS 5781 |
| 2454097.3646 | 5342.5 | -0.0108 | IBVS 5781 |
| 2454097.4984 | 5343 | -0.0154 | IBVS 5781 |
| 2454114.2573 | 5403.5 | -0.012 | IBVS 5781 |
| 2454114.3927 | 5404 | -0.0151 | IBVS 5781 |
| 2454474.2846 | 6703.5 | -0.0197 | IBVS 5837 |
| 2454777.8156 | 7799.5 | -0.0259 | IBVS 5871 |
| 2454777.954 | 7800 | -0.026 | IBVS 5871 |
| 2454862.6967 | 8106 | -0.03 | IBVS 5894 |
| 2455144.9085 | 9125 | -0.0302 | IBVS 5920 |
| 2455566.6972 | 10648 | -0.0364 | IBVS 5992 |
| 2455946.6664 | 12020 | -0.0426 | IBVS 6029 |
| 2456246.8793 | 13104 | -0.0435 | IBVS 6042 |
| 2458105.0490 | 19813.5 | -0.06982 | this paper |

The $O-C$ values in this research, combined with those from other astronomers in the past, were fitted by Quadratic Polynomial Fitting Method, as shown in Figure 4 [5].

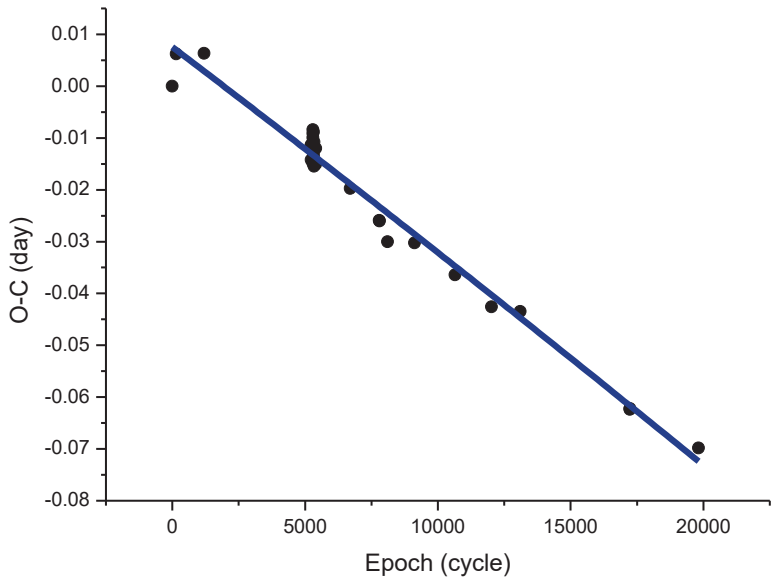


**Figure 4.** *O-C* Diagram of the V1851 Ori.

The $O-C$ diagram in Figure 3 shows the decreasing period change of the binary system V1851 Ori. The best solution to the quadratic ephemeris is shown as follows:

$$O-C = -6.75647\times10^{-12}E^2 - 3.90051\times10^{-6}E - 0.00757 \quad (2)$$

The quadratic ephemeris equation shows that the value of the period change (*dP*/*dE*) in this binary system V1851 Ori is 2(-6.75647 × $10^{-12}$) day/cycle. That means the period is decreased, changing continuously by approximately 1.54 × $10^{-3}$ seconds/year. Therefore, the stars in this system are closing and will merge in the future. It explains by the AML theory. This is caused by the magnetic field distortion that the consequence is that the separate stars evolved into one star.

## 4. Conclusions

The eclipsing binary system V1851 Ori was observed on 17 December 2017, UT at the Regional Observatory for the Public, Chachoengsao, Thailand, and was analyzed by photometry technique. The light curve of V1851 Ori showed that the time of minimum of V1851 Ori was *HJD* 2458105.0490. The $O-C$ diagram and the solution clearly show the period change (*dP*/*dE*) in this binary system V1851 Ori is 2(-6.75647 × $10^{-12}$) day/cycle or approximately 1.54 × $10^{-3}$ seconds/year. It means the distance between two stars is decreased. This might be a mass transfer effect [6] and the magnetic field variation. Finally, the binary stars will combine with a star whose evolution corresponds to the AML theory.

## 5. Acknowledgements

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**Author Contributions**:

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**Conflicts of Interest**: The authors declare no conflicts of interest.

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