*The 16th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun*
*ASP Conference Series, Vol. 448, Electronic Edition*
*Christopher M. Johns-Krull, Matthew K. Browning, and Andrew A. West, eds.*


# The Starspot Activities of Active Binary XY UMa from 2004 to 2005

Sheng-hong Gu,[1] Sacit Ozdemir,[2] and Kang Min Kim[3]

[1]*National Astronomical Observatories/Yunnan Observatory, CAS, Kunming 650011, Yunnan Province, China*

[2]*Department of Physics, Faculty of Arts and Sciences, Ahi Evran University, Kirsehir, Turkey*

[3]*Korea Astronomy and Space Science Institute, 61-1, Whaam-dong, Yuseong-gu, Daejeon, 305-348, Korea*

**Abstract.** We observed the active binary XY UMa by using 40cm telescope and CCD camera of Canakkale Observatory, 1m telescope and CCD camera of Yunnan Observatory in 2004 and 2005. The obtained BVRI photometric light curves are analyzed by means of Wilson-Devinney code, and the starspot parameters are derived for the system. The results demonstrate that the main spots are located in the medium latitude regions during our observing runs. Finally, we have discussed the spot evolution from 2004 to 2005.

## 1. Introduction

The eclipsing RS CVn binary XY UMa attracts some research groups to do photometric observations for studying its starspot activity (Lister et al. 2001; Pribulla et al. 2001). Its light curves show variability due to the presence of dark starspots on the primary of the system. The observational evidence demonstrates that the starspot structure of the primary changes in short and long time scales. Thus, it is necessary to monitor its starspot activity so that we can obtain its accurate activity cycle. Since 2004, we have begun long-term observations for XY UMa by means of multi-color CCD photometry and high-resolution spectroscopy, and the goal is providing enough information on its magnetic activity to infer its accurate activity cycle. Here, we present the preliminary photometric results based on the observations made at Canakkale Observatory, Turkey and Yunnan Observatory, China in 2004 and 2005.

## 2. Observations and data reduction

The photometric observations were performed by using CCD camera and BVRI filters of 40cm telescope at Canakkale Observatory on May 4-23, 2004 and CCD camera and BVRI filters of 1m telescope at Yunnan Observatory on Jan. 29-Feb.3, 2005. The observed CCD images are reduced by using IRAF package according to standard fashion. The photometry of XY UMa and comparison stars is carried out by using IRAF/Apphot task, and the derived BVRI light curves are displayed in Figs.1-3.

## 3. Light curve analysis

To derive the system and starspot parameters of the active eclipsing binary XY UMa, we have applied the new version of Wilson-Devinney code (Wilson & Devinney 1971) to the observational light curves. The adopted and derived parameters of the system are listed in Table 1. Because the light curves of XY UMa vary in short time scale, we separate all data to three datasets, the dataset1 includes the observations on 2004.5.4-7, the dataset2 includes the observations on 2004.5.17-23, the dataset3 includes the observations on 2005.1.29-2.3. According to our new photometric solution in Table 1, the light contribution of the secondary is just about 3-8% in BVRI bands, so its starspot activity cannot affect the observed light curves obviously. Thus, we put two spots on the primary of XY UMa to reproduce the observed light curves, and the results are satisfied. The fitting between theoretical models and observations is also illustrated in Figs. 1-3, and an example of system configuration is shown in Fig.4. The starspot parameters of the primary are listed in Table 2.

Table 1. The parameters of active eclipsing binary XY UMa

| Parameter | Value |
|---|---|
| Spectral type | G2V+K5V (Lister et al. 2001) |
| Period (days) | 0.47899604 |
| $T_1$ (K) | 5700 |
| $T_2$ (K) | 4254±10 |
| q | 0.61 (Pojmanski 1998) |
| i (degrees) | 80.860 (Pribulla et al. 2001) |
| $\Omega_1$ | 3.3510±0.0048 |
| $\Omega_2$ | 4.3868±0.0068 |
| $g_1$ | 0.32 |
| $g_2$ | 0.32 |
| $A_1$ | 0.5 |
| $A_2$ | 0.5 |
| $L_1/(L_1+L_2)$ (B) | 0.9733 |
| $L_1/(L_1+L_2)$ (V) | 0.9579 |
| $L_1/(L_1+L_2)$ (R) | 0.9397 |
| $L_1/(L_1+L_2)$ (I) | 0.9227 |
| $r_1$ (pole) | 0.3601±0.0006 |
| $r_1$ (point) | 0.4117±0.0012 |
| $r_1$ (side) | 0.3750±0.0007 |
| $r_1$ (back) | 0.3922±0.0009 |
| $r_2$ (pole) | 0.1901±0.0004 |
| $r_2$ (point) | 0.1959±0.0005 |
| $r_2$ (side) | 0.1918±0.0004 |
| $r_2$ (back) | 0.1949±0.0004 |

## 4. Discussion

Based on above results, although the dataset1 and 2 do not cover the whole orbital phase of binary system, some useful clues still can be obtained. In Table 2, we can find

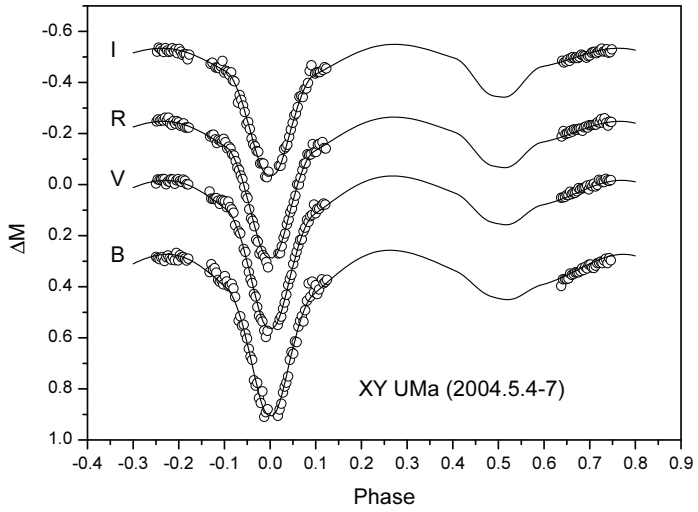


Figure 1. The observed and theoretical light curves of dataset1 for XY UMa.

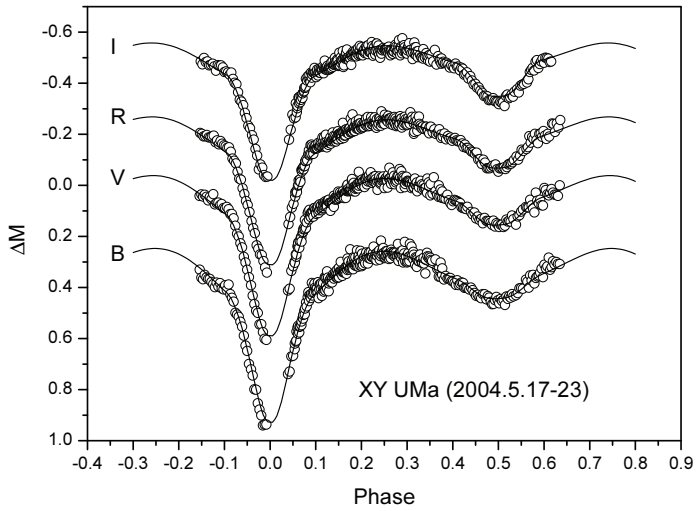


Figure 2. The observed and theoretical light curves of dataset2.

out that the starspot configuration evolves from May 2004 to Jan.-Feb. 2005. In two runs of May 2004, the spot1 is stable basically, and the spot2 moves from longitude 145 degrees to 190 degrees. If we assume two spots in Jan.-Feb. 2005 are from the ones in May 2004, the spot1 moves to higher latitude and smaller longitude from 2004 to 2005, and the spot2 moves to higher latitude and much smaller longitude. This indicates that the spot1 almost locates in the same favorite longitude belt, and the spots2 immigrates too much during our observing runs. In Dec. 2005, we observed XY UMa by using 1.8m telescope and BOES spectrograph of BOAO, Korea. These high-resolution spec-

troscopic data were already reduced and their LSD profiles were derived. The next step is analyzing the time series of LSD profiles by using Doppler imaging code DoTS to reconstruct the starspot patterns of two components for XY UMa. By that time, we shall discuss the starspot property of XY UMa more detailedly.

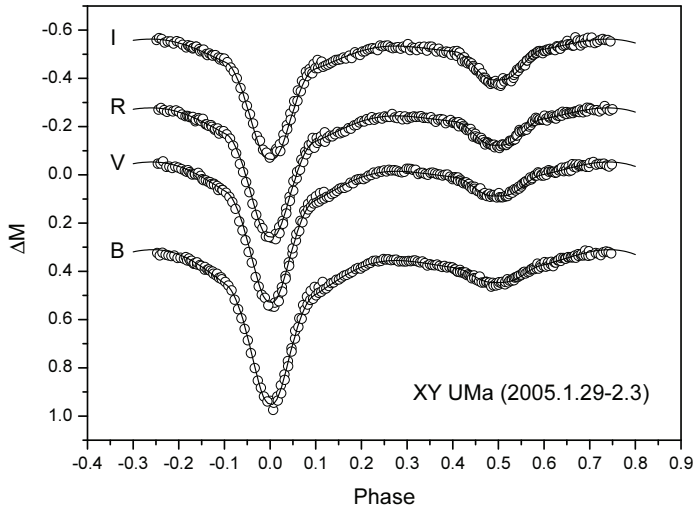


Figure 3. The observed and theoretical light curves of dataset3.

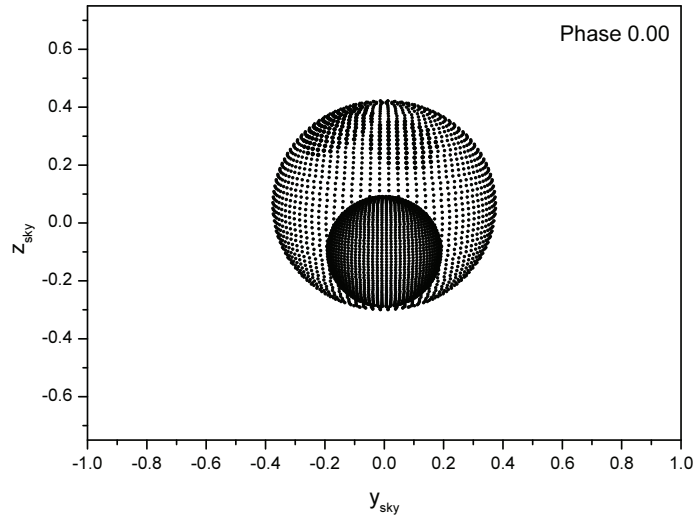


Figure 4. The configuration of XY UMa based on the dataset3.

Table 2. The starspot parameters of the primary of XY UMa

| Date | Parameter | Spot1 | Spot2 |
|---|---|---|---|
| 2004.5.4-7 | Co-latitude (degrees) | 54.79 | 62.13 |
| | Longitude (degrees) | 352.40 | 145.41 |
| | Radius (degrees) | 18.09 | 14.09 |
| | Temp. factor | 0.716 | 0.730 |
| 2004.5.17-23 | Co-latitude (degrees) | 54.57 | 56.03 |
| | Longitude (degrees) | 356.94 | 190.29 |
| | Radius (degrees) | 19.20 | 12.41 |
| | Temp. factor | 0.692 | 0.716 |
| 2005.1.29-2.3 | Co-latitude (degrees) | 34.48 | 44.32 |
| | Longitude (degrees) | 306.36 | 15.18 |
| | Radius (degrees) | 21.70 | 18.35 |
| | Temp. factor | 0.809 | 0.874 |

**Acknowledgments.** This work is supported by NSFC under grants No. 10373023 and No. 10773027.

**References**

Lister, T., Collier Cameron, A., & Hilditch, R. 2001, MNRAS, 326, 1489
Pojmanski, G. 1998, AcA, 48, 711
Pribulla, T., Chochol, D., Heckert, P. A., Errico, L., Vittone, A. A., Parimucha, S., & Teodorani, M. 2001, A&A, 371, 997
Wilson, R. E., & Devinney, E. J. 1971, ApJ, 166, 605