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THE UPDATED ORBITAL PERIOD OF LOW MASS X-ray BINARY 4U 1323-62

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ABSTRACT

4U 1323-62, a low mass X-ray binary with an orbital period of 2.94 hr, exhibits periodic X-ray dips, which are due to absorption by the bulge of the outer accretion disk. The purpose of this study is to search for orbital period changes using archived X-ray data over a time span of 20 years. We present our preliminary results from analyzing light curves observed by RXTE, BeppoSAX, XMM-Newton and Suzaku. We used the method proposed by Hu et al. (2008) to estimate dip center time and adopted the Observed - Calculated method to measure changes in period. We obtained an orbital period of 2.941917(36) hr and a period derivative of $\dot{P}_{orb}/P_{orb} = (-9.9 \pm 3.5) \times 10^{-7} yr^{-1}$. The F-test result shows that the quadratic ephemeris is describes the evolution of the dip phases better than the linear ephemeris at a greater than 95% confidence level. More X-ray data collected from the early 80s will be included to further refine the orbital ephemeris.

Key words: X-rays: binaries: 4U 1323-62

1. INTRODUCTION

4U1323-62 is a low mass X-ray binary, discovered by Uhuru (Forman et al. (1978)), exhibiting periodic dips in its X-ray band. The dip period was first detected by Parmar et al. (1989) with a value of 2.932(5) hr by template profile fitting using the EXOSAT light curves collected in February 1985. Bałucińska-Church et al. (1999) eported a period of 2.938(20) hr from analyzing the light curves collected by BeppoSAX. We attempt to refine the orbital ephemeris of 4U1323-62 and search for the orbital period derivative using archived data with a time span of more than 20 years. The preliminary results are reported in this paper.

2. OBSERVATIONS AND DATA REDUCTION

4U1323-62 has been observed by many X-ray telescopes over a time span of greater than 20 years. The preliminary results reported in this paper come from analyzing the light curves collected by RXTE , BeppoSAX, XMM-Newton, and Suzuku from 1997 to 2007. All the data have been reduced and the light curves have been calculated except for the XMM-Newton data. XMM-Newton light curves were produced by SAS (XMM-Newton Science Analysis Software). All the times of the light curves were corrected to the barycenter of the solar system for further analysis.

3. DATA ANALYSIS

The dip profiles were obtained by folding the light curve with the linear ephemeris $T_N = MJD(TDB)46107.928(1) + 0.12217(21) \times N$ proposed by Parmar et al. (1989). Figure 1 shows a typical dip profile for 4U1323-62. As the dip profile is complicated, we adopted the method proposed by Hu et al. (2008) to extract the dip center time and its corresponding orbital phase (hereafter dip phase). The errors were evaluated from the uncertainties of the count rate in light curves, which contain only the photon statistical errors. However, because the dip is believed due to the occultation of the bulge on the disk rim where the mass flow stream impacts, unlike the eclipsing profile, the dip phase is not complete locked with the orbital motion but shows phase jitter (about 0.015 cycles for X 1916-053, Chou et al. (2001) , Hu et al. (2008)). To estimate the phase jitter, we used data collected over a short time span. Over a short time, the phase drift from orbital derivatives is small and can be neglected. Therefore the phase drift is mainly from the difference of true orbital period and folded period. To estimate the phase jitter, we assumed that the uncertainty of dip phase is only contributed to by statistical errors and phase jitter. The phase jitter was evaluated by calculating the root mean square of data over a short time span. The phase jitter of 4U1323-62 is 0.02 cycles.

The phase jitter was then quadratically added into the statistical errors of all data. The dip phase evolution was fitted with a linear function and we obtained an

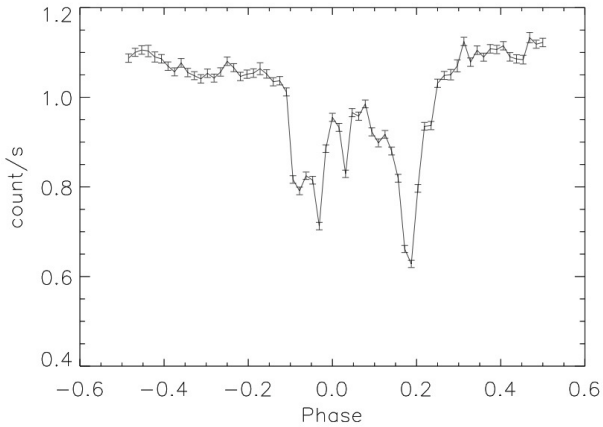

Figure 1. The folded light curve for 1997/04/25 22:02:56 1997/04/26 03:56:32.

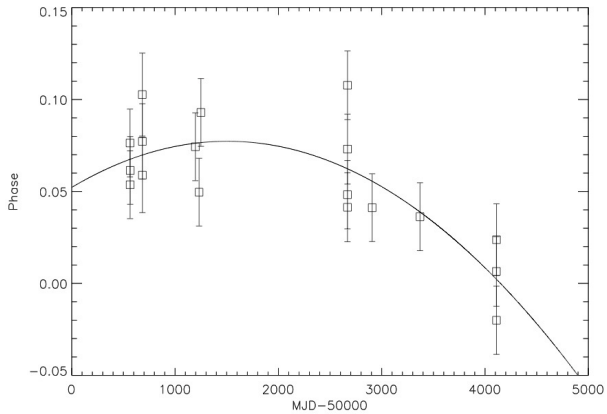

Figure 2. Quadratic fitting of the phases of dip center times observed between 1997 and 2007

acceptable fitting result with $\chi^2 = 22.58$ of 16 degree of freedoms. The fir parameters are listed in Table 1. The linear ephemeris is updated to be

$$T_N = MJD(TDB)52733.349(24) + 0.1225799(15) \times N$$

To probe the orbital derivatives, we fit the dip phase evolution with a quadratic curve (see Figure 2) and obtained a period derivatives of $\dot{P}_{orb}/P_{orb} = (-9.9 \pm 3.5) \times 10^{-7} yr^{-1}$. The F-test results show that the F value is 7.8, which indicates that adding a quadratic term significantly improves the fitting with a confidence level of more than 95% . We therefore established the quadratic ephemeris as

$$\begin{aligned} T_N &= MJD(TDB)52733.2395(18) \\ &\quad +0.1225972(64) \times N - 2.03(73) \times 10^{-11} \times N^2 \end{aligned}$$

The quadratic fitting results are also listed in Table 1.

4. DISCUSSION

We analyzed the dip phase evolution of 4U1323-62 from data between 1997 and 2007 and updated the orbital ephemeris during this 10 years period. An orbital period derivatives of $\dot{P}_{orb}/P_{orb} = (-9.9 \pm 3.5) \times 10^{-7} yr^{-1}$, which is slightly larger than the expected value for a low mass X-ray binary$of \dot{P}_{orb}/P_{orb} = 10^{-8} - 10^{-7} yr^{-1}$, was detected. More data will be included into this study in future and the orbital period derivatives will be further refined.

Table 1
THE RESULTS OF LINEAR FITTING AND QUADRATIC FITTING TABLE

	Linear fitting	Quadratic fitting
Constant term	0.90(20)	-29(11)
Linear term	$-1.61(38) \times 10^{-5}$	$1.13(41) \times 10^{-3}$
Quadratic term	-	$-1.10(40) \times 10^{-8}$
χ^2	22.6	14.9
d.o.f	16	15
Reduce χ^2	1.41	0.990

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