

Long-term optical variability of Her X-1

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Abstract. Long-term and short-term multicolor photometric variations of the X-ray binary system Her X-1 (HZ Her) has been studied. We obtained new VRI observations of the system by using the 60cm Robotic telescope at the TÜBİTAK National Observatory (TUG) in 2018. Using newly obtained data, we modified the orbital period of the binary system with a neutron star component.

Keywords. stars:binaries, X-rays: binaries, stars: individual (HZ Her, Her X-1)

1. Introduction

Her X-1 (HZ Her, 4U1656+35) was discovered in 1972 from UHURU satellite observations (Tananbaum *et al.* 1972). The system is an eclipsing intermediate-mass X-ray binary (IMXB) system with a 1.7 days orbital period. The binary system contains an accreting neutron star with 1.5 M_{\odot} and 2.2 M_{\odot} optical component. The spin period of the compact star is about 1.24 seconds. The distance of Her X-1 was estimated by Reynolds *et al.* (1997) as 6.6 kpc which is similar to the Gaia result.

Her X-1/HZ Her observed in various wavelengths including optical, ultraviolet, radio and X-ray bands. Both short and long-term optical observations of the system have been obtained by different studies (e.g., Shakura *et al.* 1997; Cherepashchuk *et al.* 1974; Simon *et al.*, 2002; İçli 2016). The light curve of the binary system shows peculiar variability. In addition to an optical variation, the system shows a 35 days variability in X-rays (Scott *et al.*, 2000; Leahy & Abdallah 2014; Postnov *et al.* 2013). The 35-day cycle variations could be related with an accretion disc.

Observation of the long-term variability of X-ray binary system with neutron star component provides information about the physical processes with a time scale of few decades. These variations can be due to the stellar activity of the component star, as well as hot stellar winds, accretion properties, the disrupted shape of the component and the eclipsing feature of the systems. In this work, we aimed to study long-term multi-color (VRI) light variations of binary systems consisting of a neutron star and an early-type component. We present our preliminary results on Her X-1.

2. New Observations

The new optical observations of Her X-1 was obtained using the 60cm robotic telescope (T60) at the TUBITAK National Observatory (TUG) between years 2015 and 2018 in VRI filters. The exposure times were set to 60 s for all filters. The recent observations of 2018 are presented in this study. Observations of each data set were reduced separately with the standard procedure by using IRAF/PHOT. The frame reduction was performed by subtracting the bias and dark frames and finally dividing by flat-field frames. For each system, four comparison stars have been selected that were used in previous studies.

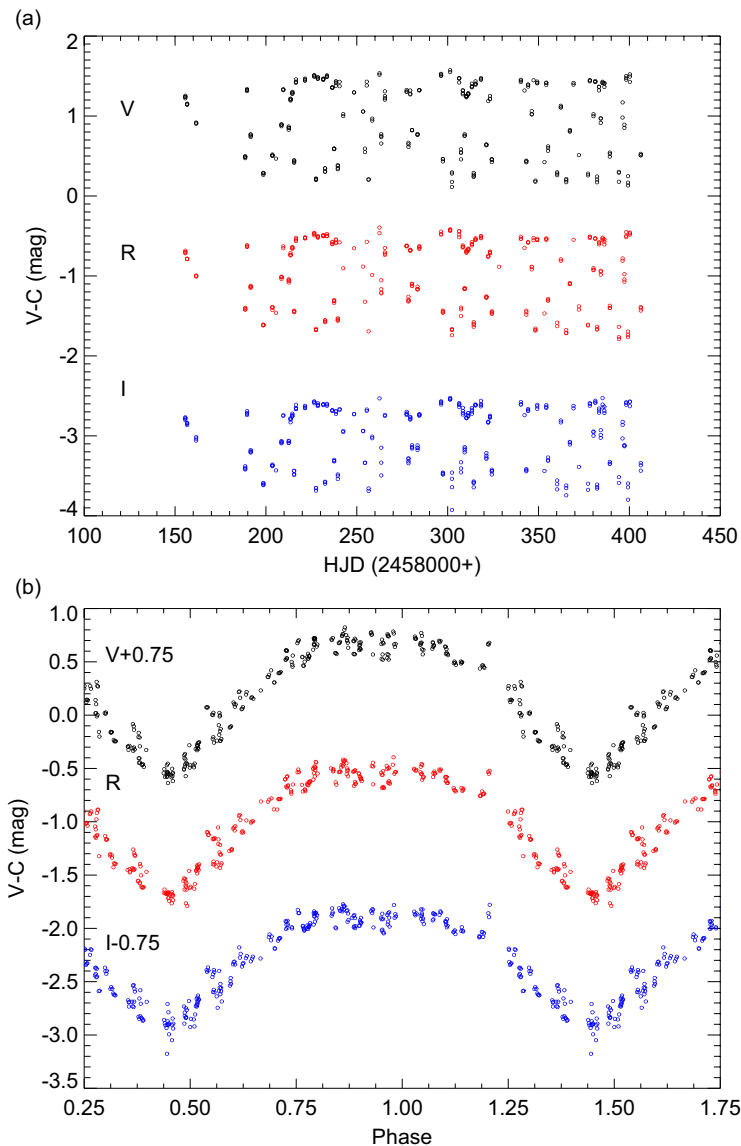


Figure 1. Long-term VRI light variation of Her X-1 (a) and light curves of the system (b) obtained in 2018.

AAVSO-135, AAVSO-132, AAVSO-150, and AAVSO-136 were chosen as a comparison and check stars, respectively.

Obtaining our new VRI observations, we decide to derive an orbital period of the system. We obtained the orbital period of the system as 1.699646(8). Figure 1a shows the long-term light variation of Her X-1 spreading over 250 nights. The complete light curves of the system, obtained in V, R and I bands are shown in Fig 1b. Long-term optical monitoring of Her X-1 is still ongoing.

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