High-mass X-ray Binaries: Illuminating the Passage from Massive Binaries to Merging Compact Objects
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Multicolour photometry of SS 433

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Abstract. We presented long-term optical observations of the high mass X-ray binary system SS 433 (V1343 Aql) with a black hole component. New observations have been obtained by using the 0.6m telescope at the TÜBİTAK National Observatory (TUG) in B, V, R and I filters. We aim to investigate the long-term photometric behavior of the system.

Keywords. stars:binaries, X-rays: binaries, stars: individual (SS 433, V1343 Aql)

1. Introduction

Following a core collapse/supernova, massive stars leave behind either a neutron star or a black hole at the end of their evolution. The processes may differ for a single star and for a star that is a member of a binary system. In binary systems, the massive component evolves faster to form an X-ray binary system. One of the components in an X-ray binary system is a black hole or a neutron star. X-ray binary systems can be divided into three classes as low mass X-ray binaries (LMXB), intermediate mass X-ray binaries (IMXB), and high mass X-ray binaries (HMXB); depending on their physical features. The number of known IMXB systems, with intermediate mass stellar components, is relatively low. Podsiadlowski, Rappaport, & Pfahl (2001) presented an evolutionary study of the LMXBs and IMXBs. HMXBs contain O-B type highly massive stars that lose mass via hot stellar winds. In addition to the stellar winds, active regions on the stellar surface and the oblate shape of the component can play important roles in the light variation of a system. Long-term light variations of these kinds of systems have been studied in the literature by, e.g. Goranskij (2011); Reig & Fabregat (2015), and Kocak (2016).

SS 433 (V1343 Aql, α= 19 11 49.56, δ= +04 58 57.8) is an eclipsing HMXB system (P_{orb}=13.08223 days) containing a ∼5-16 $M_{\odot}$ black hole and A3-7 type supergiant component (Cherepashchuk 1981, Gladyshev 1981, Margon 1984, Fabrika 2004) with a distance of 5.5 kpc. The system was the first Galactic microquasar to be identified that shows relativistic ($V_{jet} \sim 0.3c$) jets (Abell & Margon 1979; Fabian & Rees 1979, Fabrika 2004). Various researchers observed the system SS 433 at different wavelengths. The system was observed photometrically by Volkov (2012), Kurochkin (1988),Goranskii *et al.* (1998), Goranskij (2011), and Chakrabarti *et al.* (2003).

2. New Observations

New multicolor observations of SS 433 were carried out at the TÜBİTAK National Observatory with the 0.6-meter telescope (TUG-T60). The system was observed in Bessell B, V, R, and I filters in 2015, 2016, 2017, 2018 using the TUG-T60 robotic telescope. The frame reduction performed by subtracting the bias and dark frames and finally dividing by flat frames. We used 60 and 90 seconds of exposure time in the observations. We

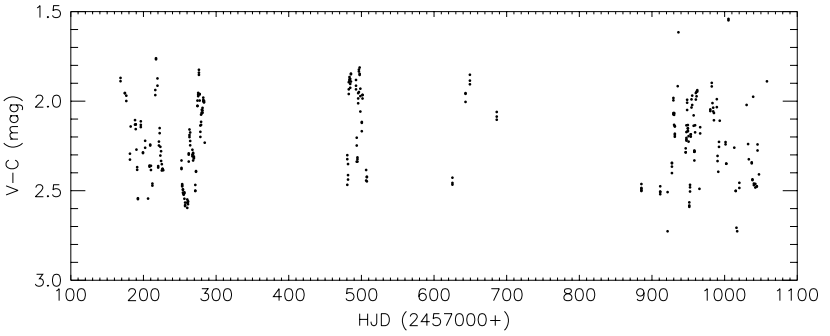

Figure 1. Long-term light variation of the system in R filter.

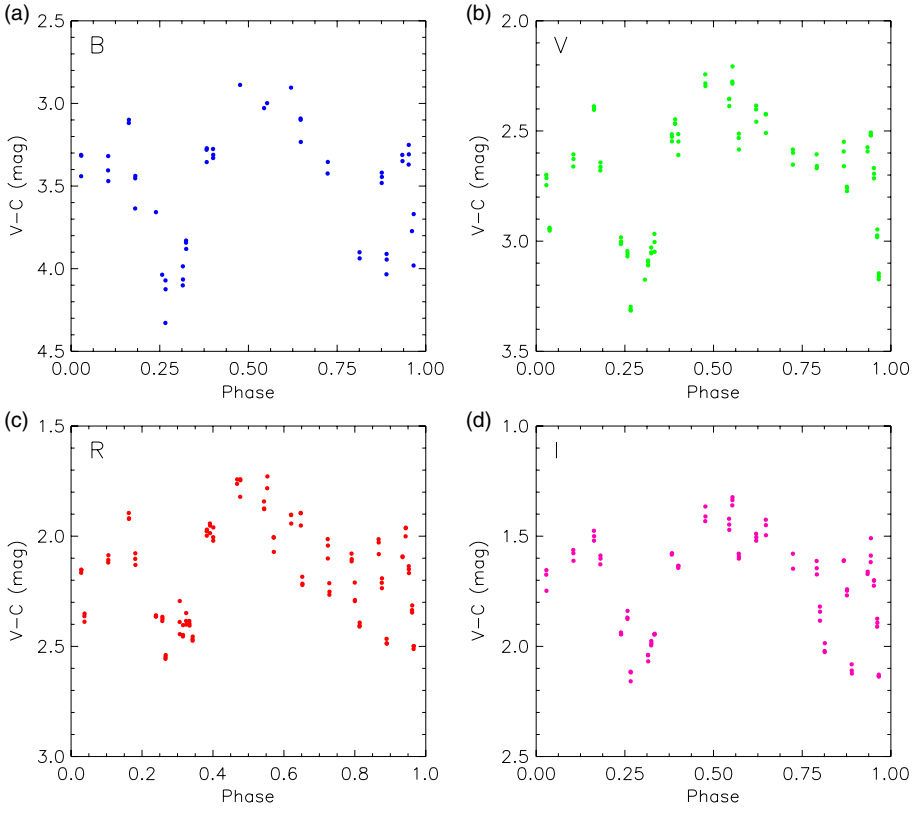

Figure 2. The light curves of the eclipsing X-ray binary V1343 Aql in B (a), V (b), R (c) and I (d) filters.

present the long-term light variation of the system in Figure 1 and multi-color (BVRI) light curves for SS 433 in Figures 2a-d. The phases were calculated using the ephemeris given by Koçak (2016).

Light curves of the system show a significant variation with the amplitude of 1.3 mag in B, 1.1 mag in V, 0.9 mag in R and 0.8 mag in I bands. All the new observation details for the selected X-ray binaries will be discussed in our next study (Koçak *et al.* 2019).

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