Appearance of Special UGSU-type Phenomenon in the Light Curve of UGZ White Dwarf Nova RX Andromedae

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Abstract The dwarf nova RX Andromedae was examined using data from the AAVSO International Database. It is classified as a Z Cam (UGZ)-type dwarf nova. The cycle of outbursts is short due to the high accretion rate, approximately 13 days. The object has been in standstill several times over the last two decades, as well observed by the AAVSO. According to previous studies, RX And exhibited VY Scl-type light changes. During the analysis of the AAVSO light curve I established that specific UGSU-type characteristics have also developed in RX And since 5 August 2014. Every fourth outburst is a superoutburst, the period of the supercycle being about 55.5 days. The superoutbursts are brighter and longer than other normal outbursts. The superoutburst itself (~10.7 magnitude) is superpositioned on the precursor normal outburst (~11.0 magnitude). It can be established that the precursor triggers the superoutburst. However, we can find uncertainties in the recently-appearing UGSU-type feature of RX And; the star differs from the behavior of a typical UGSU dwarf nova in a number of aspects. Unlike UGSU stars the orbital period of RX And is above the period gap, and in the light curve of RX And there is not any indication of the presence of superhumps. The amplitude of the superoutburst exceeds that of a normal outburst by about 0.4 to 0.5 magnitude. This value is less than the 2 to 4 magnitudes characteristic of UGSU stars. Also, one should be careful in making conclusions, because the investigated period (from 5 August 2014 to 1 February 2015) is not long enough to judge whether the phenomena appearing in the light curve are really supermaxima. The long orbital period and the lack of superhumps in any case need further explanation. As for whether the supercycle remains stabilized in the star, and whether the UGSU characteristics are a normal stage of development for all UGZ dwarf novae or only typical of RX And, remain to be established by further investigations.

1. Introduction

The RX And system has been classified as a Z Cam-type dwarf nova, showing alternating standstills and dwarf nova outbursts (Simonsen *et al.* 2014). Outbursts around 11.0 magnitude were observed from the minimum approximately every 13 days. The pattern of the outbursts was identical to the single peak profile typical of dwarf novae. The brightness varies between the minimum of ~14.5 magnitude and the maximum of ~11.0 magnitude. The continuous cycle was sometimes interrupted by standstills lasting 60 to 90 days. The orbital period of the system is 5.04 hours. The white dwarf of 1.14 $M_{\odot}$ accretes material over from the secondary component with a high accretion rate (Godon and Sion 2003), due to which the average period of outbursts is only about 13 days. Over the past 20 years, the system indicated standstills typical of UGZ stars around 11.5 magnitude.

A significant fraction of cataclysmic variables show phases of low luminosity in their long term light curves. These low states appear to be a general phenomenon among the VY Scl stars, a subclass of the novalike variables. Earlier studies have shown that RX And also has characteristics of a VY Scl star (Schreiber *et al.* 2002). At JD 2450350–2450455 RX And was found in a deep low state, V ~15.4, fainter than the typical quiescent level of V ~14.5. According to Schreiber *et al.* this deep minimum state, having a length of 100 days, is an indication of the VY Scl properties of the system. It should be noted that light decreasing in VY Scl stars are 2 to 4 magnitudes while RX And is only 1 magnitude, but the amplitude and duration of the low states strongly vary between the members of the VY Scl class. Also, Schreiber *et al.* indicated that in morphological terms the low states appearing in the light curve of RX And are similar to the light change observed in diskless AM Her stars having extensive magnetic fields. There is an important difference, however: RX And is a dwarf nova having an accretion disk and it is a non-magnetic system.

RX And has undergone nearly every type of behavior seen in dwarf novae, creating one of the more interesting light curves among dwarf novae (Templeton 2007).

2. Data analysis

The behavior of RX And was analyzed based on the AAVSO light curve. RX And has a long and well observed light curve in the AAVSO International Database (Kafka 2015), with near continuous coverage throughout the recent decades. The continuous curve of several decades is particularly accurate and the high amplitudes of light changes allow visual estimates to be accurate enough for substantial conclusions on the properties of the changing star.

3. Discussion

In the course of analyzing the light curve of RX And, I could establish that the system had been exhibiting UGSU-type superoutbursts since 20 October 2011. The supercycle developed continuously over several years. The uncertain supercycle started to appear on the light curve from JD 2455469. The first definitely identifiable superoutburst took place at JD 2455856 (Figure 1). A cycle that is typical to UGSU stars started to appear on the light curve of RX And from JD 2456876, in which every fourth outburst is a superoutburst (Figure 2).

While RX And was visible in the autumn of 2015 the

superoutburst appeared again at JD 2457277. However, the existence of a supercycle is uncertain, because the fourth superoutburst after JD 2457277 cannot be identified unambiguously (Figure 3).

4. Results

I established that the normal outbursts are about 11.0 magnitude at maximum, and the superoutbursts generally reach an average value of 10.7 magnitude. The length of the normal outburst is about 9.33 days and the superoutbursts are about 17 days long, based on the superoutburst, appearing from time to time since 2010, and on the four superoutbursts occurring in the period from 5 August 2014 to 1 February 2015. The period of the supercycle created by the superoutbursts based on the above period is about 55.5 days. Additionally, the system has a special pattern of superoutbursts. I found that every superoutburst is associated with a precursor. The superoutburst is superpositioned on the precursor normal outburst of about 11.0 magnitude; the precursor thereby triggering the superoutburst (Figures 1 and 4).

4.1. UGSU-type phenomenon in the light curve of RX And

From 5 August 2014 a supercycle developed in the light curve in which the superoutbursts are brighter and longer than other normal outbursts. The precursor-triggered superoutburst, however, is not an exclusive feature of RX And. The precursors were first well-studied in the Kepler sources V344 Lyr and V1504 Cyg (Cannizzo *et al.* 2012). Furthermore, a precursor-triggered superoutburst can be observed in the light curve of the dwarf nova V516 Lyr in the Kepler field (Kato and Osaki 2013).

4.2. Uncertainties in UGSU-type properties

We can find uncertainties in the recently-appearing UGSU-type feature in RX And, and the star differs from the behavior of a typical UGSU dwarf nova in a number of aspects.

The known SU UMa stars lie below the period gap (that is, a 2- to 3-hour orbital period gap for dwarf novae) but the orbital period of RX And is 5.04 hours.

A typical UGSU superoutburst generally exceeds normal outbursts by 2 to 3 magnitudes. In the case of RX And the amplitude of the superoutburst exceeds that of a normal outburst by about 0.4 to 0.5 magnitude, but there are several SU UMa stars that only show increases by this amount.

During superoutbursts the light curves of UGSU stars show superposed periodic oscillations (superhumps), their periods being close to the orbital ones and with amplitudes that are 0.2 to 0.3 magnitude.

In the accurate AAVSO light curve of RX And, however, there is not any indication of the presence of superhumps.

A further source of uncertainty is that the investigated period (from 5 August 2014 to 1 February 2015) is not long enough to judge unambiguously that the new outburst behavior is really a superoutburst, and whether the supercycle really has occurred. The long orbital period and the lack of superhumps, in any case, need further explanation.

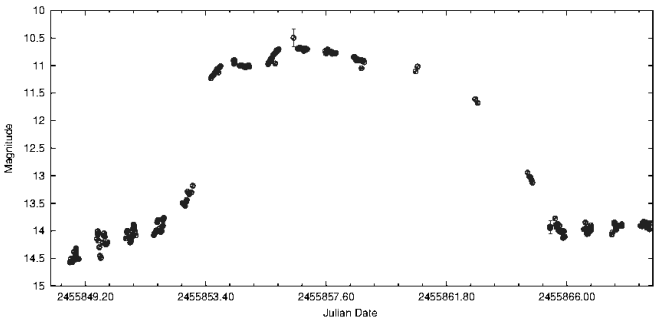

Figure 1. The first definitely identifiable superoutburst of RX And at JD 2455856.

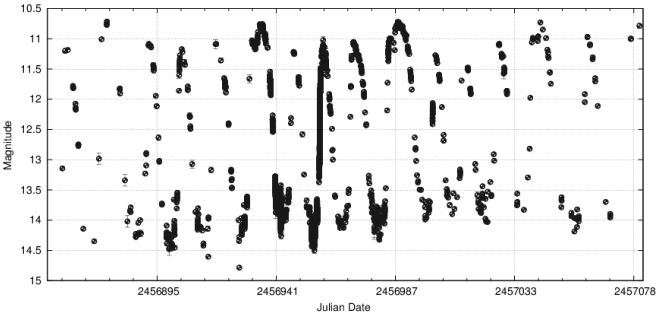

Figure 2. The RX And supercycle identifiable from JD 2456876 to JD 2457042 in which every fourth outburst is a precursor superoutburst.

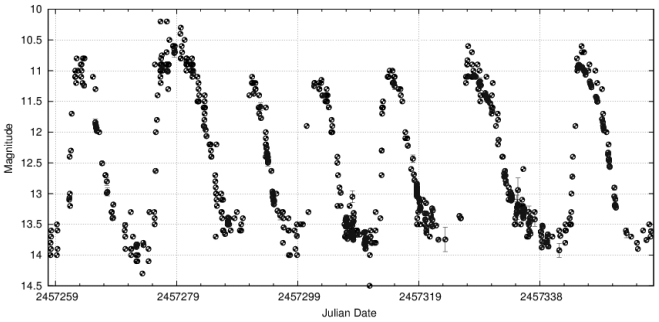

Figure 3. Light curve of RX And from 24 August 2015 to 1 December 2015.

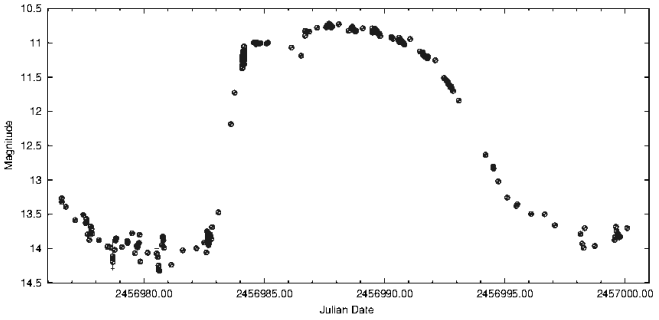

Figure 4. RX And superoutburst at JD 2456987. The superoutburst of about 10.7 magnitude is superpositioned on the precursor normal outburst of about 11.0 magnitude.

5. Conclusion

RX And has essentially exhibited features of all types of dwarf novae over the last two decades. The basic question is whether the different types of dwarf novae represent the phases of the development of objects, through which phases every dwarf nova or UGZ dwarf nova passes, or whether it is a special characteristic of RX And. Further examinations have to be carried out to establish whether or not the supercycle in the star remains stable and unchanged, and whether or not it simultaneously preserves standstills that are typical to UGZ types.

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