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## Reassess RZ Cas light curves at primary minima during 1995-1996

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## 1 Introduction

The Algol binary RZ Cas (HD 17138) has been well-known for its irregular and sudden period change(SPC)s. Even though the primary minimum is due to partial occupation, occasionally flat bottoms which resemble a total eclipse are observed at the mid-primary minimum (e.g., Narusawa et al. 1994).

In order to study the cause of flat bottoms and their relations to SPCs, we have carried out corporative photometry of RZ Cas at five places in Japan from January 1995 to December 1996 (three seasons). The observations were conducted with photoelectric photometry at three observatories and CCD photometry at two. At all the observatories, the $V$ or $R$ colour filters similar to the standard Johnson-Kron-Cousins system were used.

The results have already been reported as Narusawa et al (1997, Paper I). Back then, we reported that six partial eclipses were observed, however apparent flat bottoms did not appear in the primary minima during our observational period (see Table 2 of Paper I).

Ohshima et al. (1998, 2001) have found a $\delta$ Sct type nonradial pulsation (NRP) with a frequency of 64.20 cycles day$^{-1}$(22 min) whose maximum amplitude is 0.02 mag. This has led us to understand that the flat bottom is synthesized with the light variation of the partial eclipse and those of the oscillations. Moreover, Ohshima et al. (2001) categorized the shapes into four types; the "F-type" with a flat bottom; the "V-type" with a V-shaped curve; and the "S-type" with a slant increasing or decreasing smoothly. Furthermore, the subtypes "Sa" and "Sb" were classified which indicate an ascending slant and a descending one respectively. According to the explanation by Ohshima (2001), when the light maximum of the $\delta$ Sct pulsation coincides with the center of eclipse, the F-type is observed. When the light minimum of pulsation coincides with the mid-primary eclipse, the V-type light curve is observed. The intermediate case is the S-type. In addition to Ohshima et al. (2001)'s classifications, we defined a partial-eclipsed curve, the "P-type" which appears when the amplitude of pulsation is small.

Table 1: Shape of light curves at the primary minima

| Obs. Date | HJD 2400000+ | Filter | Shape | Observer |
|---|---|---|---|---|
| 1995/01/06 | 49723 | $V$ | P: | Arai |
| | 49723 | $V$ | - | Ohmori |
| 1995/01/25 | 49743 | $V$ | - | Ohmori |
| 1995/09/27 | 49988 | $V$ | - | Yasuda |
| 1995/10/03 | 49994 | $R_c$ | - | Fujii |
| 1995/10/21 | 50012 | $V$ | V | Nagai |
| 1995/10/27 | 50018 | $V$ | P | Arai |
| 1995/11/02 | 50023 | $V$ | Sa | Arai |
| | 50023 | $R_c$ | Sa-F | Fujii |
| 1995/11/09 | 50031 | $R_c$ | F: duration $\sim$ 20min | Fujii |
| 1995/12/21 | 50072 | $V$ | (Sa-)F duration $\sim$ 10min | Arai |
| 1995/12/27 | 50078 | $V$ | P: | Arai |
| 1996/12/28 | 50445 | $V$ | - | Nagai |

## 2 Reassessments and Results

We reassessed the shapes of Paper I's light curves at primary minima, for $\delta$ Sct pulsations were not detected at that time. The results are listed in Table1, and some of the light curves are shown in Figures 1-4. As shown in Table 1, the F-, Sa-, and V-type light curve shapes appeared during the 1995/1996 seasons. Because only the P-types were observed in Paper I, we concluded that the amplitude of the $\delta$ Sct type pulsation was small during this period. However, the observations from Narusawa & Nakamura (2020) also found Sa- and Sb- types on 1995 November 2 and 3, leading us to believe that the amplitude was not actually so small during this season.

Narusawa et al. (2006) performed H$\alpha$ spectroscopic observations of RZ Cas on 1995 September 27 and October 3, and they discovered circumstellar matter in this system. Mkrtichian et al. (2018) proposed that the presence of circumstellar matter causes a decrease in the pulsation amplitude. However, since all shapes of light curves at the bottom of primary eclipse were observed in this season, the presence of circumstellar matter did not cause the amplitude of $\delta$ Sct type NRP to decrease for RZ Cas.

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**Reference:**

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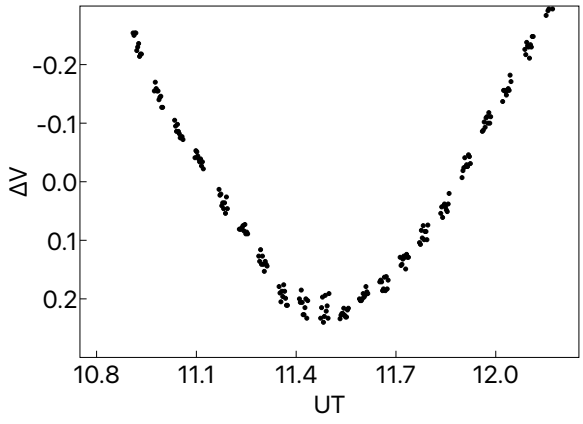


Figure 1: The light curve on Jan. 6 1995 observed by Arai.

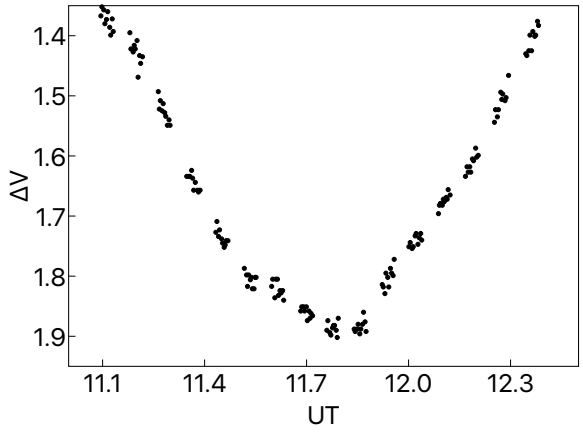


Figure 2: The typical Sa type light curve on Nov. 2 1995 observed by Arai.

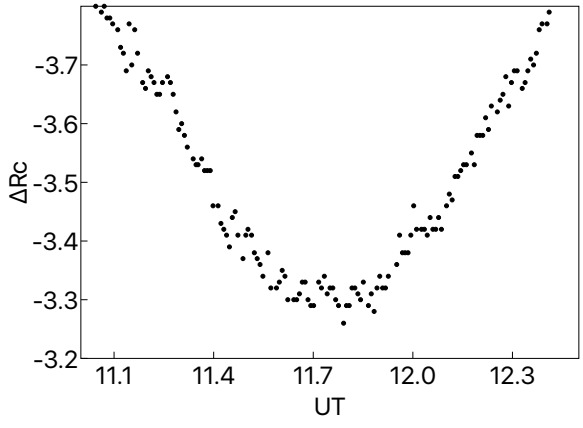


Figure 3: The light curve on Nov. 2 1995 observed by Fujii.

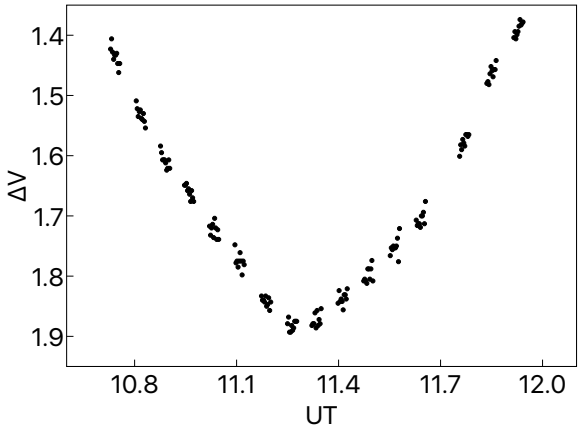


Figure 4: The light curve on Dec. 27 1995 observed by Arai.

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