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LIGHT CURVES AND PERIODS OF THE RR LYRAE STARS SU Cha AND SW Cha

A system of dark clouds in the constellation Chamaeleon was first investigated by Hoffmeister (1962) who detected a large number of variable stars, many of which being members of what is now called the Cha T1 association. In a search for flare events in this region (Winterberg 1995, Winterberg et al. 1995), we found two variables which were identified with Hoffmeister's variables SU Cha (classified as RR Lyr star) and SW Cha, which is misclassified in the GCVS (Kholopov et al., 1985) as being of type Is: and which many authors regard as a member of the Cha T1 association. However, we unambiguously identify it as another RR Lyr star, unrelated to the association.

During four observing runs in 1985, 1986, 1989 and 1990 a total of 45 multiple exposure plates in 22 nights were obtained on IIa–O plates at ESO's 40cm–GPO telescope at La Silla. Each plate contains chains of (in general) 6 exposures of 10 minutes each.

An automatized routine was used to separate the individual exposures on each plate and to determine magnitudes. The coordinate transformation, based on 22 PPM stars (Röser & Bastian 1988, Bastian et al. 1991), is accurate to within $0\farcs3$. Magnitudes were determined using methods developed by Cunow (1993). Since all standard stars are rather bright, an extrapolation was required for the fainter stars on the photographic plate. Thus, in addition to statistical uncertainties faint magnitudes may suffer from systematic errors. Therefore, not much weight should be given to the absolute values of the magnitude scale. Period determination is, however, not affected by these errors. For further details concerning the reduction procedures, see Aniol (1989) and Winterberg (1995).

SU Cha

SU Cha was detected as a variable star of RR Lyr type by Hoffmeister (1962) who gave it the preliminary designation S6316. He derived a period of 0.618757 days. The finding chart published by Hoffmeister (1963) leaves no doubt that the star we detected in our observations is identical to SU Cha. Improved coordinates are: $\alpha = 10^{\rm h}50^{\rm m}14^{\rm s}$ (2000.0) and $\delta = -78°24'51''$ (2000.0). A light curve was published by Gessner (1980), confirming the original classification. She found the period to be 0.6189 days. No further observations of SU Cha have come to our knowledge.

Our observations are distributed over a time base of 5 years. An Analysis-of-Variance periodogram (AoV) (Schwarzenberg-Czerny 1989) was calculated from our data and yielded a highly significant peak. The light curve folded on the corresponding period is shown in Figure 1. It is typical for RRab type stars. We derived a period and an epoch of maximum as given by the ephemeris:

$$\text{Max} = \text{HJD}\,2447914.755 \pm 31 + 0^{\text{d}}.618858 \pm 10 \times \text{E}$$

Here, the error of the period is arbitrarily and conservatively fixed to a value which would lead to an easily recognizable phase shift of 0.05 over the entire time base of the observations. Similarly, the error of the zeropoint is fixed at 5% of the pulsation period.

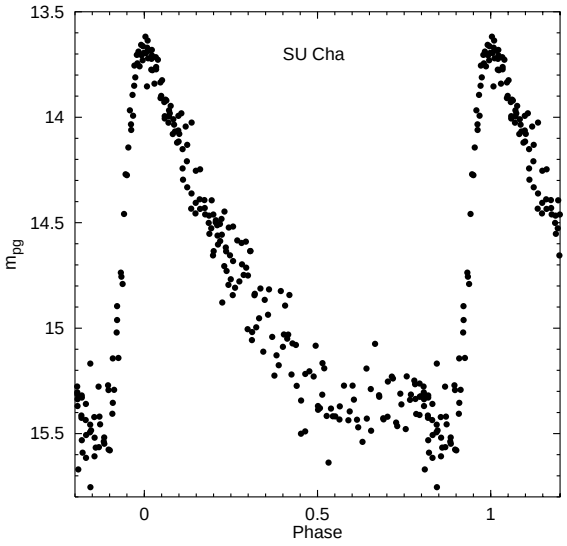

Figure 1. Light curve of SU Cha folded on the pulsation period 0.618858 days

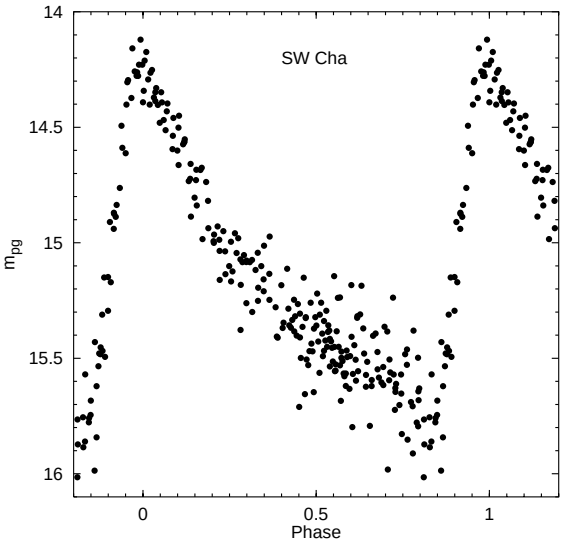

Figure 2. Light curve of SW Cha folded on the pulsation period 0.458430 days

The period is practically identical with that found by Gessner (1980) but more accurate. She quotes 8 times of maximum for the 1959 observing season of SU Cha. This permits to calculate $O-C$ values over a long time base, using the above period and maximum epoch. The mean value is as small as 0.005 ± 0.024 days (0.013 ± 0.022 days, assuming that Gessner did not apply the heliocentric correction) indicating that the derived period leads to negligible phase errors over a time base of more than 30 years. Taking the mean $O-C$ value and its statistical error as indicative of the true uncertainty of the period, a more realistic error should then be 2×10^{-6} days instead of the conservative estimate of 1×10^{-5} days quoted above.

SW Cha

The literature on SW Cha is somewhat more extensive than that of SU Cha, albeit not much. SW Cha was also discovered by Hoffmeister (1962) who gave it the preliminary designation S6319. The chart published by Hoffmeister (1963) again leaves no doubt that the star discussed here is indeed SW Cha. Improved coordinates are: $\alpha = 10^{\text{h}}54^{\text{m}}13^{\text{s}}$ (2000.0) and $\delta = -77°55'9''$ (2000.0). It was originally classified as similar to RW Aur, while according to the GCVS it is of type Is:. Gessner (1980) suspected SW Cha to be an RR Lyr star. She quotes four epochs of brightenings but does not show a light curve.

Rydgren (1980) took a single photometric measurement in *UBVri* (r and i being non-standard bands). Assuming that SW Cha is a member of the Cha T1 association he found it to lie below the main sequence. He concluded that SW Cha is probably a background object unrelated to the association. This is also supported by the fact that unlike many

other members of the Cha T1 association SW Cha was not detected by *IRAS* (Gauvin and Strom 1992). However, for reasons which are not quite obvious, Whittet et al. (1987) classify it as a member, and subsequent publications (Gregorio-Hetem et al. 1990, Gauvin and Strom 1992, Schwartz 1991, Hartigan 1993) do not put the membership into question.

However, we show beyond any reasonable doubt that SW Cha is not a member of the Cha T1 association and that Hoffmeister's (1962) original classification was erroneous. In contrast, Gessner's (1980) suspicion was correct.

Using the same procedure as in the previous case we unambiguously found a periodic variation in the brightness of SW Cha. The AoV periodogram showed also in this case a highly significant peak. The light curve, folded on the corresponding period, is shown in Figure 2. The shape of the light curve together with the value of the period leave no doubt about the classification of SW Cha as an RRab type star. The ephemeris for the maxima is:

$$\begin{array}{rcl} \mathrm{Max} = \mathrm{HJD}\,2446093.862 & + & 0\overset{\mathrm{d}}{.}458430 \times \mathrm{E} \\ \pm\ 23 & & \pm\ 6 \end{array}$$

The errors are defined in the same way as in the case of SU Cha.

Interpreting the four epochs of brightening quoted by Gessner (1980) as genuine maxima, the above ephemeris leads to a mean $O - C$ value of 0.133 ± 0.056 days. Taken at face value this would indicate that the true period (assuming a constant period) is $(6.5 \pm 2.7)\,10^{-6}$ days shorter, just consistent with the (conservative) error. However, the observed brightenings need not necessarily correspond to the true maxima but to nearby epochs (with a higher probability for lying after a maximum than before, considering the shape of the light curve). Then, the true period may be somewhere between the one given in the ephemeris and a period shorter by $\approx 6.5 \times 10^{-6}$ days.

Schwartz (1991) lists in his Table 1 a spectral type of M0: for SW Cha. The source of this classification remains unclear. It does not fit in with the colours $B - V = 1.14$ and $U - B = 0.78$ measured by Rydgren (1980). In contrast, the colours are consistent with those of a highly reddened ($E_{B-V} \approx 0.9$) star of type A7 III – F0 II (Schmidt-Kaler 1982). This is well in the range of RR Lyr stars, and the dereddened colours also correspond to an RR Lyrae star (Clube et al., 1969).

Our clear detection of an RR Lyr type variability in SW Cha is at odds with the magnitude estimates of Mauder and Sosna (1975) performed on the basis of 91 photographic plates taken over a time base of 31 days. The light curve constructed from their table was also subjected to an AoV analysis. No indications of a periodic variation on time scales above an hour were detected. It is not clear why Mauder's and Sosna's data do not show any sign of periodic variability which is so clearly present in our observations.

We have obtained light curves of two RRab type variable stars, SU Cha and SW Cha. While the former was already known as an RR Lyr star, the latter was previously classified as being of type Is:. However, the light curve observed here leaves no doubt about the correct classification. The pulsation period of SU Cha could be derived to a significantly higher precision than hitherto known; that of SW Cha could also be determined with a sufficiently high precision to permit secure cycle counts for several decades. Although the unknown interstellar extinction and the errors of our photographic photometry do not allow us to make useful statements about the distance of both stars, it is obvious that SW Cha cannot be a member of the Cha T1 association (which is at a distance of only 140 pc; Whittet et al., 1987) and should be discarded from corresponding lists in the

literature. Astrometric measurements lead to positions which are significantly improved compared to the original coordinates determined by Hoffmeister (1962) and quoted in the GCVS.

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