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Times of maximum of CY Aquarii: the 2010 season

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Abstract

We present 24 new times of maximum of the SX Phoenicis star CY Aquarii. These times lead to a slightly more precise local linear ephemeris for 2003–2010.

Keywords: technique: photometric – stars: CY Aqr

1 Introduction

CY Aquarii (BD +0°4900) is a short-period (87.9 min) large-amplitude ($0^{\rm m}.71$ in V) SX Phoenicis star. Since the discovery of its variability in 1934, this pulsating star has been extensively observed, and several investigations of its changing pulsation period using the $O-C$ diagram have been published. The latest substantial set of new times of maximum of CY Aqr were presented by Tuvikene et al. (2010). This paper presents a set of timings obtained in 2010, and provides an updated linear ephemeris for the times of maximum.

2 Observations and data reduction

All the data discussed in this paper were obtained through CCD imaging at one single observing site during 12 partial nights in September–December 2010 from a rooftop location at Realgymnasium Bruneck (Südtirol, Italy). The observations were obtained by a team of students, under the supervision of CW. A 10-inch Meade LX200 telescope with an SBIG ST8-XME CCD camera was used. Typical exposure

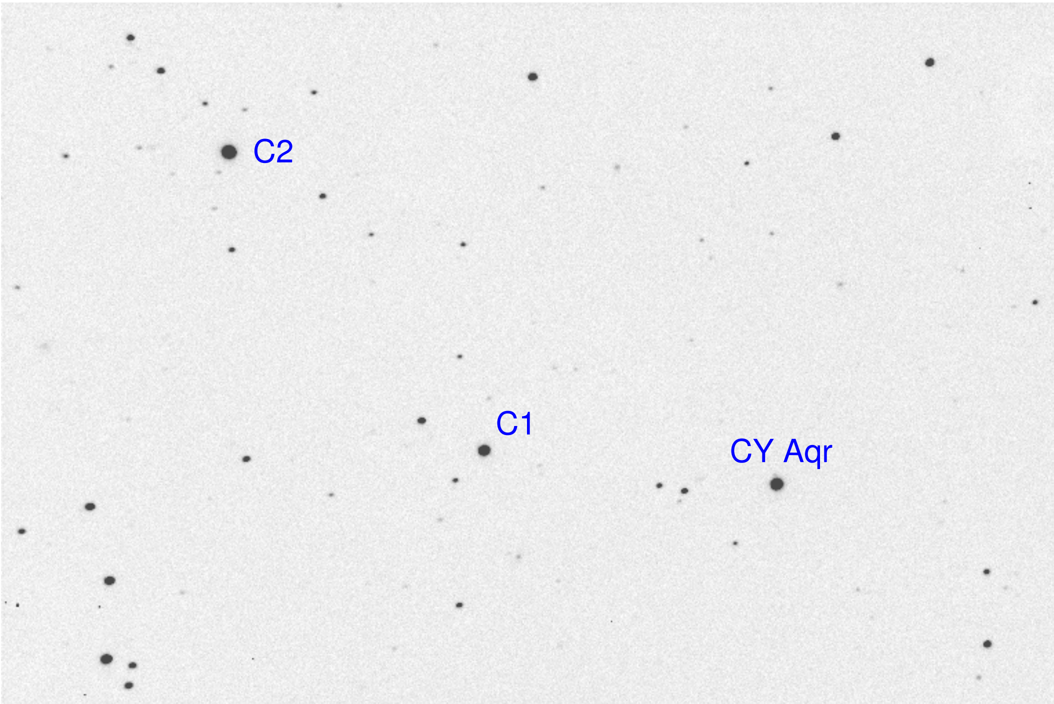

Figure 1: CY Aqr CCD frame of 11 October 2010. North is up and East is left, field of view is $18' \times 12'$. CY Aqr and the comparison stars C_1 = GSC 00567–01826 and C_2 = GSC 00567-02036 have been marked.

time was 35–50 s, with 2×2 binning, and no filter was used. The technical limitations of this rooftop equipment prevented the acquisition of valid flat-field frames, hence these CCD frames were dark-corrected only. Table 1 gives the journal of observations. Figure 1 shows a CCD frame of the CY Aqr field.

3 The light curve

CCD magnitudes were extracted by means of aperture photometry, using routines in the IDL Astronomy User's Library[1] in a workflow as described by Tuvikene (2011). Aperture sizes were scaled with the full width at half maximum (FWHM) of stellar images, and an aperture radius of 1.6×FWHM was used for all frames, see also Tuvikene et al. (2008) and Tuvikene & Sterken (2010).

Differential light curves of CY Aqr were obtained relative to GSC 00567–01826 as a comparison star. Figure 2 shows the phase diagram for 2010.

[1] `http://idlastro.gsfc.nasa.gov/`

Table 1: Journal of photometric observations: JD, number of CCD frames, differential magnitude between comparison stars, and standard deviation σ. All differential magnitudes of CY Aqr and of the two comparison stars are given in Table `rgb2010.dat`.

JD−2400000	Data	C_1–C_2	σ
55460.35 – .44	123	−1.012	0.008
55469.29 – .41	166	−1.013	0.006
55481.28 – .37	143	−1.012	0.008
55484.28 – .43	298	−1.015	0.007
55490.31 – .35	99	−1.031	0.007
55496.28 – .39	216	−1.039	0.011
55498.26 – .41	263	−1.025	0.008
55506.25 – .40	288	−1.023	0.006
55530.21 – .31	162	−1.022	0.007
55535.20 – .35	324	−1.023	0.007
55544.21 – .28	143	−1.019	0.011
55547.19 – .29	121	−1.020	0.010
Total	2346	−1.021	0.008

4 The times of maximum

Times of maximum light were determined from visual inspection of the data within $\pm 0\overset{\text{d}}{.}005$ of the moment of maximum light, supported by a moving-average line. Relative weights were assigned using the same criteria as used in Tuvikene et al. (2010), see Table 2. Table 3 lists the results, with corresponding weight factors and cycle number E.

Table 2: Relative weights assigned to the $T_{\rm max}$ derived in this work.

Weight	Data density		Shape of maximum	Comment
1	very low		(ir)regular	
2	medium	+	irregular	
3	high	+	irregular	deviations from smoothness
4	medium	+	regular	
5	high	+	regular	smooth light curve

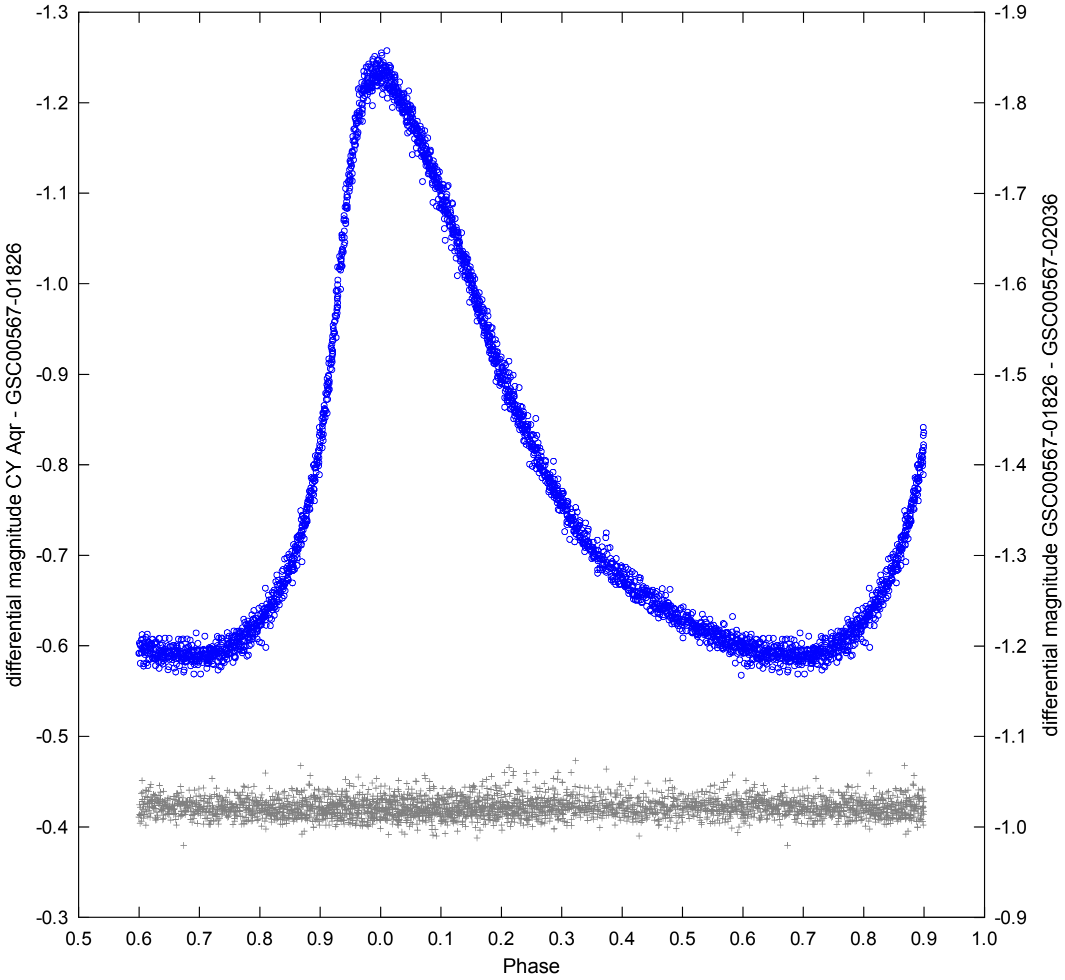

Figure 2: Phase diagram of all data, constructed with Eq. 1. ∘: differential magnitude of CY Aqr, +: difference between comparison star magnitudes.

5 Ephemeris and resulting $O-C$ diagram

A linear least-squares fit of the 24 times of maximum in Table 3 results in $P = 0\overset{d}{.}061038350 \pm 0\overset{d}{.}000000004$. This set of new times of maximum obtained in 2010 together with the 114 new timings presented in Tuvikene et al. (2010), leads to the local linear ephemeris for 2003–2010:

$$\begin{array}{rcccc} T_{\max} & = & 2426159.5122 & + & 0.061038349\,E \\ & & \pm 0.0005 & & \pm 0.000000001 \end{array} \qquad (1)$$

Figure 3 shows the new $O-C$ points overplotted in Fig. 3 of Fu & Sterken (2003) (ephemeris $T_{\max} = 2426159.4967 + 0.0610383716E$).

Table 3: Times of maximum light (HJD–2400000) of CY Aqr, weight W (Table 2), and cycle number E.

T_{max}	W	E	T_{max}	W	E
55460.3611	5	480040	55498.2662	5	480661
55460.4222	5	480041	55498.3270	4	480662
55469.3340	5	480187	55498.3883	5	480663
55469.3948	5	480188	55506.2618	5	480792
55481.2973	5	480383	55506.3225	5	480793
55481.3584	4	480384	55506.3837	5	480794
55484.2878	5	480432	55530.2500	5	481185
55484.3493	4	480433	55535.2553	5	481267
55484.4102	5	480434	55535.3163	4	481268
55490.3309	5	480531	55544.2280	3	481414
55496.3128	3	480629	55547.2188	5	481463
55496.3744	4	480630	55547.2800	3	481464

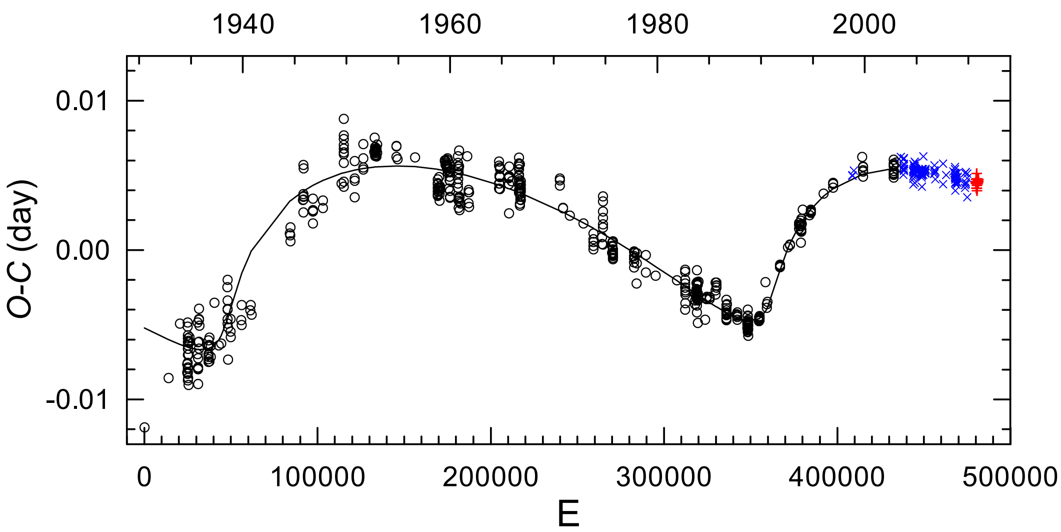

Figure 3: Resulting $O-C$ curve with respect to ephemeris (1) of Fu & Sterken (2003). Full line and $\circ$: light-time orbit solution and data from Fu & Sterken (2003); $\times$: the 114 T_{max} from Tuvikene et al. (2010) (without the two outliers shown in their Fig. 4); $+$: new T_{max} as listed in Table 3.

6 Conclusions

The pulsation period in Eq. 1 is formally identical to the one given by Tuvikene et al. (2010), though the new data provide a better accuracy on the period as well as on the initial epoch.

As stated in Tuvikene et al. (2010), it will require at least another half decade of additional monitoring before any significant update to the presented model can be considered.

Our data show that modest equipment supported by adequate training and tutoring – when sustained for at least 5 to 10 years – will provide enough evidence to conclude whether the binary model can fully account for all the period variability observed in this star.

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