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HAS AY Dra INCREASED AMPLITUDE?

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The variability of AY Dra (= BV 338 = GSC 03872 01194 = IRAS 15374+5711; $\alpha = 15^{\rm h}38^{\rm m}39.34^{\rm s}$, $\delta = 57^\circ01'33.8''$ [J2000]) was first noted by Strohmeier and Knigge (1960a). They determined variability between 10.6 and 12.6 mag on their photographic plates and a preliminary long period variable classification. Strohmeier and Knigge (1960b) observed three times of maxima and derived a pulsation period of 283.5 days. Nikulina (1961) published one time of maximum light with the remark that the star is probably of Mira type. Huth and Wittman (1968) searched photographic plates and determined 19 new times of maximum light and a new period of 262.5 days. Tsessevich and Makarenko (1983) mention that about 1400 photoelectric measurements of AY Dra are deposited in the archive of Odessa Astrophysical Observatory. However, we have been informed by I. L. Andronov that these are actually measurements of the bright eclipsing binary AI Dra. Stephenson (1985) determined an approximate M7 spectral type for AY Dra. AY Dra entered the GCVS (Kholopov et al., 1985) as a SRa type variable star. Guglielmo et al. (1997) made JHK observations of AY Dra showing that the star is oxygen rich. No observations of AY Dra can be found in the databases of amateur visual observations. Thus, the star was selected as a target for MEDUZA† observers.

We carried out visual and CCD observations of AY Dra. For the calibration of the field stars, Henden used the USNO Flagstaff Station 1.0 m telescope equipped with a SITe/Tektronix 1024 × 1024 CCD to observe the field in the standard Johnson-Cousins $BV(RI)_c$ passbands on four photometric nights, using Landolt standards to calibrate the field. Astrometry is based on USNO-A 2.0 and has less than 100mas internal error. Field photometry based on four nights is available through IBVS website as 5286-t2.txt. Sobotka and Pejcha used the 0.4 m Newtonian telescope of Nicholas Copernicus Observatory and Planetarium in Brno, equipped with an SBIG ST-7 CCD camera and VRI

† http://www.meduza.info

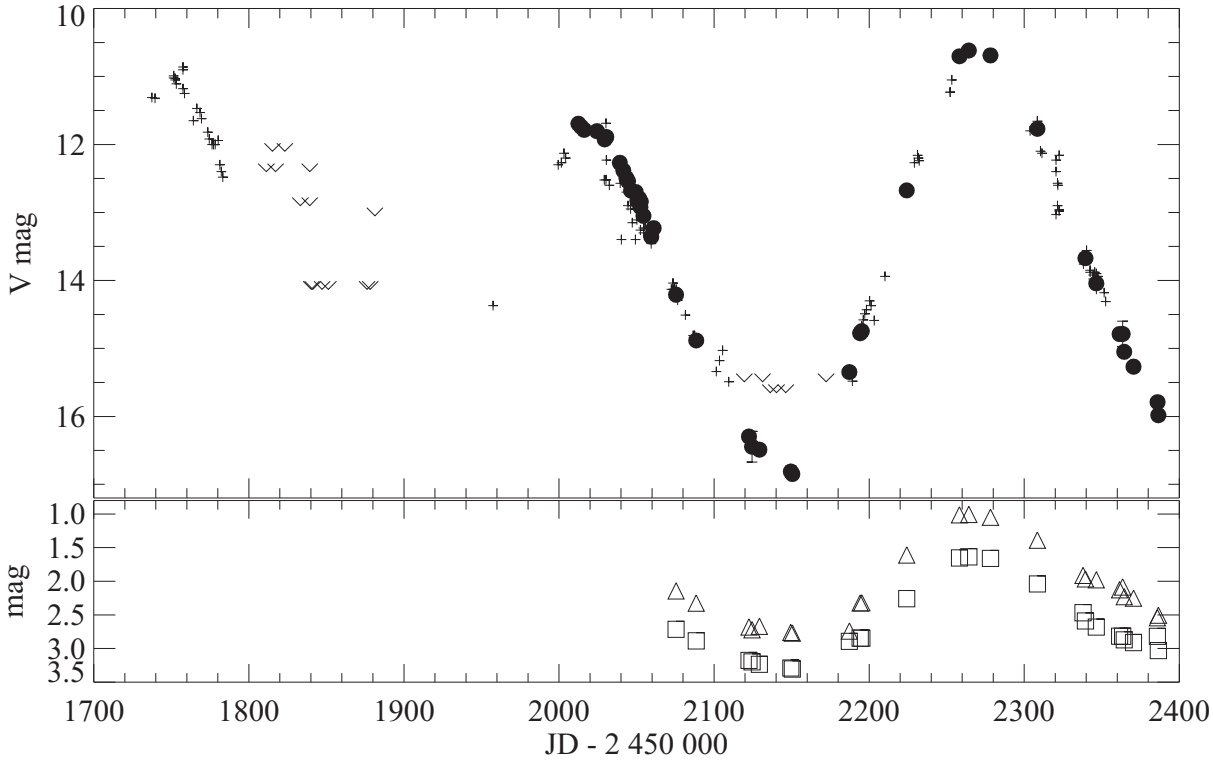

Figure 1. Light curves of AY Dra. Upper panel: plus signs are visual observations, filled circles are CCD V band measurements with corresponding error bars. "V" shaped symbols are upper limits of visual observers. Lower panel: triangles are $V - R$ values and squares are $R - I$ values (shifted by +0.2 mag for plot clarity).

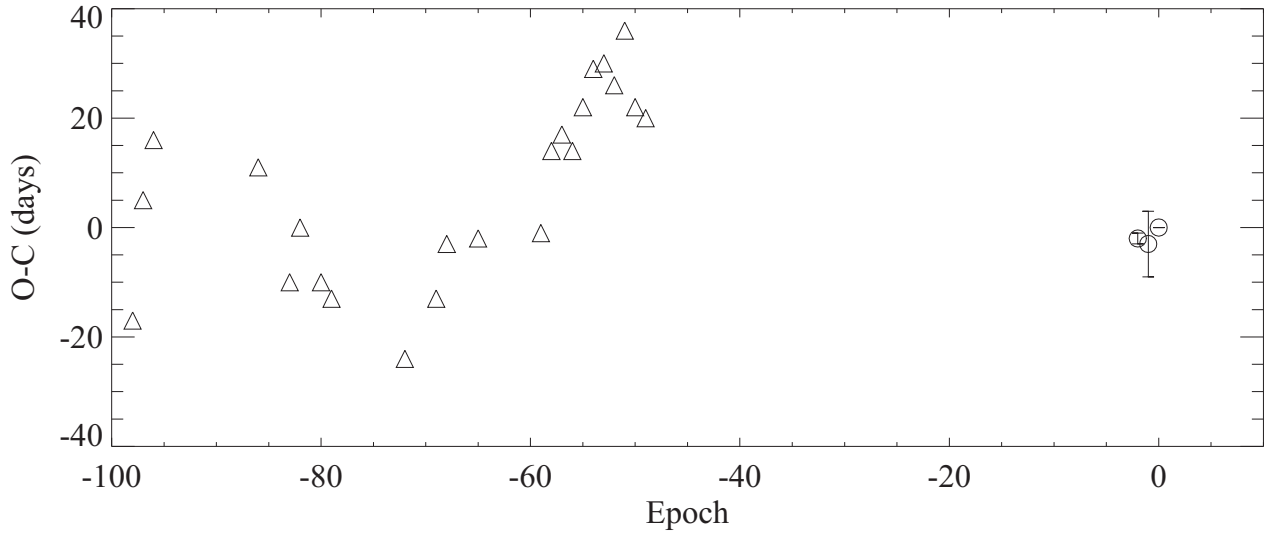

Figure 2. $O - C$ diagram of maxima timings of AY Dra based on data from Table 1 and ephemerides determined in this paper. Triangles are photographic observations and circles with error bars maxima from this paper.

filters. Frames (typically two to six in each band per night) were processed using MUNIDOS 2.2 (Hroch, Novák and Král, 2001). Observations were transformed to the standard Johnson-Cousins photometric system. Systematic zero-point shifts should be below 0.2 mag. Šmelcer employed the 0.28 m Schmidt-Cassegrain telescope of the Valašské Meziříčí Observatory with an SBIG ST-7 camera and V filter. CCDOPS software bundled with SBIG cameras was used for photometry. Dubovský, Brát and Pejcha made visual observations using 30, 25 and 25 cm Dobsonian telescopes, respectively. A few additional estimates were made by other MEDUZA members. The magnitudes of the comparison stars were based on magnitudes from TYC, TYC-2, GSC and field photometry from this paper; the finding chart can be found at the MEDUZA web page. As visual observations agree well with simultaneously taken CCD measurements, we find their precision adequate. Visual observations are available through the MEDUZA web page and CCD observations from the authors upon request.

Figure 1 shows the CCD V band and visual light curve as well as $V-R$ and $R-I$ color curves. For clarity, weighted averages of CCD observations made on the same night with the same filter and by one observer were plotted. Magnitude errors served as weights.

In Table 1 we present times of maximum light collected from literature and determined from our observations using the Kwee and von Woerden (1956) method as implemented in AVE (Barbera 2000). To create a denser dataset, visual observations and CCD V band timings were both used. The timing of the last maximum was determined separately in each passband and the final value in Table 1 is weighted average from the three passbands as no obvious difference is seen in times of maximum light determined in different filters. Linear regression using all times of maximum light yields the following ephemeris:

$$\begin{array}{rll} \text{Max.} = \text{JD } 2452275.0 & + 261.94 \times E. \\ & \pm 0.5 \qquad\quad \pm 0.08 \end{array}$$

Our best observed maximum was chosen as the fundamental epoch. We assigned double weights to maxima determined in this paper. An $O-C$ diagram based on the ephemeris shown above and data from Table 1 is presented in Figure 2.

Our light curve amplitudes in the VRI filters are 6.0, 3.9 and 2.4 mag, respectively. Our amplitude in the V band is about three times higher than that of Strohmeier and Knigge (1960a). Comparison between currently known V band amplitudes for other stars with amplitudes given in Strohmeier and Knigge (1960a) do not show any difference higher than 0.2 mag. This means that, the amplitude of AY Dra has increased by a factor of three, leaving the maximum brightness roughly unchanged. Such a phenomenon has not been observed among classical Mira variables, but some semiregulars seem to exhibit such amplitude modulation. Kiss et al. (2000) attributed variations of amplitude with constant maximum brightness to a combination of nonradial pulsations and rotation, which seems to be quite unlikely for Mira variables. $B-V$ values of AY Dra near minimum light do not indicate presence of any hot companion. We would like to invite astronomers to look through archives of photographic plates to confirm or disprove this possible amplitude variation of AY Dra.

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This work has made use of the SIMBAD database, operated at CDS, Strasbourg, France. The NASA ADS Abstract Service was used to access data and references.

Table 1: Maxima timings of AY Dra

Geo. JD	Error	Filter	Epoch	$O-C$	Observer	Source	Remark
2426588		pg	−98	−17	Strohmeier&Knigge	BV 11,6	
2426872		pg	−97	−5	Strohmeier&Knigge	BV 11,6	
2427145		pg	−96	16	Strohmeier&Knigge	BV 11,6	
2429759		pg	−86	11	Huth	MVS 4,176	uncertain
2430524		pg	−83	−10	Huth	MVS 4,176	
2430796		pg	−82	−0	Huth	MVS 4,176	
2431310		pg	−80	−10	Huth	MVS 4,176	uncertain
2431569		pg	−79	−13	Huth	MVS 4,176	
2433391		pg	−72	−24	Huth	MVS 4,176	
2434188		pg	−69	−13	Nikulina	AT 227,17	
2434460		pg	−68	−3	Huth	MVS 4,176	
2435247		pg	−65	−2	Huth	MVS 4,176	
2436820		pg	−59	−1	Wittman	MVS 4,176	
2437097		pg	−58	14	Wittman	MVS 4,176	
2437361		pg	−57	17	Wittman	MVS 4,176	
2437620		pg	−56	14	Wittman	MVS 4,176	
2437890		pg	−55	22	Wittman	MVS 4,176	
2438159		pg	−54	29	Wittman	MVS 4,176	
2438422		pg	−53	30	Wittman	MVS 4,176	
2438680		pg	−52	26	Wittman	MVS 4,176	
2438952		pg	−51	36	Wittman	MVS 4,176	
2439200		pg	−50	22	Wittman	MVS 4,176	
2439460		pg	−49	20	Wittman	MVS 4,176	
2451749	1	V+vis	−2	−2	this paper	this paper	
2452010	6	V+vis	−1	−3	this paper	this paper	
2452275	0.5	V+R+I+vis	0	0.0	this paper	this paper	basic maximum

References:

Barbera, R., 2000, `http://www.astrogea.org/soft/ave/aveint.htm`
Guglielmo, F. et al., 1997, *A&AS*, **122**, 489
Hroch, F., Novák, R., Král, L., 2002, `http://munipack.astronomy.cz`
Huth, Von H., Wittman, A., 1968, *MVS*, **4**, 176
Kholopov, P. N. et al., 1985, *General Catalogue of Variable Stars*, 4th edition, Moscow
Kiss, L. L., Szatmáry, K., Szabó, G., Mattei, J. A., 2000, *A&AS*, **145**, 283
Kwee, K. K. and Van Woerden, H., 1956, *BAN*, **12**, No. 464, 327
Nikulina, T.G., 1961, *Astr. Tsirk.*, **227**, 17
Stephenson, C. B., 1985, *IBVS*, 2657
Strohmeier, W., Knigge, R., 1960a, *Bamb Veröff*, **5**, 6
Strohmeier, W., Knigge, R., 1960b, *Bamb Veröff*, **5**, 11
Tsessevich, V. P., Makarenko, E. N., 1983, *Astr. Tsirk.*, **1273**, 6