Astron. Astrophys. 363, 1019–1025 (2000)

ASTRONOMY AND ASTROPHYSICS

Spectral, photometric and speckle observations of visual binary WDS 00550+2338

V.S. Tamazian[1], **J.A. Docobo**[1], **N.D. Melikian**[2,3], **N. Baba**[4], **and V.H. Chavushyan**[5]

[1] Astronomical Observatory "Ramon Maria Aller", P.O. Box 197, 15706 Santiago de Compostela, Spain (oatamaz@usc.es; oadoco@usc.es)
[2] Byurakan Astrophysical Observatory, reg. Aragatsotn, 378433, Armenia (nmelikia@bao.sci.am)
[3] Isaac Newton Institute of Chile, Armenian Branch
[4] Hokkaido University, Department of Applied Physics, Sapporo 060-8628, Japan (nbaba@eng.hokudai.ac.jp)
[5] Instituto Nacional de Astrofisica, Optica y Electronica, Apartado Postal 51 y 216, C.P. 72000, Puebla, Pue., Mexico (vahram@inaoep.mx)

Received 18 May 2000 / Accepted 10 July 2000

Abstract. New spectral classification, photometric and speckle measurements of visual binary star WDS 00550+2338 are presented. The composite spectrum confirms it belongs to the late type subgiants (K0 IV) and is located above the main sequence. Speckle spectroscopy data allowed us to classify A and B components separately as G8 IV and K3 IV. A brightness increase of $0\overset{\mathrm{m}}{.}56$ and $0\overset{\mathrm{m}}{.}28$ in B and V colors, respectively, has been detected during 27 hours of BV photometric observations in the course of two observing runs in 1997 and 1999. New astrometric data are presented confirming the good quality of the last published orbit for this star. On the basis of its orbital data and parallax the total mass of the system, close to $2M_{\odot}$, is derived. It is suggested that registered variability looks similar to flare-like events usually observed in young pre-main sequence stars, while further photometric observations are needed to confirm the character of variation. No significant polarization signal has been detected for this star.

Key words: stars: binaries: visual – stars: individual: WDS 00550+2338 – stars: variables: general

1. Introduction

Among visual binaries with variable components, late type young pre-main sequence (PMS) stars (T Tau, flare stars) constitute an interesting subclass of newly formed stellar systems. It is known that multiplicity is rather common among these stars (Evans 1977). Recent studies of a number of T Tau stars in various star-forming regions confirmed the presence of companion stars bound gravitationally to the primary star (Ghez et al. 1995; Simon et al. 1993). The binary star frequencies suggest that T Tau stars are 2 to 4 times more likely to have a companion in the separation range from 1–150 AU (Simon et al. 1992; Simon 1995) than solar-type main sequence (MS) stars. As regards wider separations (150 -1800 AU), this trend is not so evident (Brandner et al. 1996) despite the excess of PMS binaries found by Reipurth & Zinnecker (1993).

Send offprint requests to: V.S. Tamazian

The prevalence of binary and multiple systems at early stages of stellar evolution shows that a system of this kind is the most probable outcome of the star-forming process. Under the assumption that PMS and MS binary frequencies should be the same, such excess implies that binary orbits in the star forming regions undergo secular evolution towards the MS. The increasing number of such systems, as well as precise knowledge of their orbital and astrophysical parameters, enable investigators to constrain the star formation models as well as indicate their possible evolutionary tracks.

It is worth noting that the study of relationships between dynamical and astrophysical parameters in binary systems represents one of the most interesting research fields in modern astrophysics, especially in view of the growing spatial resolution of the largest telescopes with an unprecedent capacity (milliarcseconds) to resolve extremely close systems. This allows unbiased measurement of physical parameters for each component separately.

One must note, however, that often astrophysical parameters are determined or derived for many stars as a single object while in reality they are double (or sometimes even multiple) systems. In such cases, derived parameters may serve only as orientative values, without describing real physical properties of any concrete component.

In the course of our ongoing study of late type visual binaries with variable components (Tamazian et al. 1997, 1999) we have observed a number of systems with K and M type primaries with either known or suspected, but not yet confirmed, (or characterized) variability.

This article presents the results of BV photometric monitoring, spectrum, speckle spectroscopy data, speckle interferometric and polarimetric observations of the visual binary WDS 00550+2338 (=HD 5286=ADS 755), which is also catalogued as NSV 343 in the New Catalogue of Suspected Variable Stars (Kukarkin et al. 1982).

The spectral type K1 IV, corresponding to the composite spectrum, is known (Abt 1981; Keenan & McNeil 1989). According to Edwards (1976), its components A and B are late type G6 IV (V=6.1) and K6 IV (V=6.7) stars respectively, sep-

Table 1. Photometric data for WDS 00550+2338

Date	JD	Time (UTC)	B	V	B−V
25.11.1997	2450778.708	17^h00^m	6.74	5.65	+1.09
	2450778.833	20 00	6.72	5.62	+1.10
26.11.1997	2450779.694	16 40	6.79	5.69	+1.10
	2450779.784	18 50	6.68	5.59	+1.09
	2450779.816	19 35	6.69	5.59	+1.10
27.11.1997	2450780.667	16 00	6.70	5.60	+1.10
	2450780.740	17 45	6.69	5.61	+1.08
	2450780.833	20 00	6.13	5.33	+0.80
28.11.1997	2450781.722	17 20	6.74	5.65	+1.09
01.12.1997	2450784.667	16 00	6.74	5.63	+1.11
	2450784.729	17 30	6.70	5.63	+1.07
	2450784.809	19 25	6.75	5.60	+1.15
	2450784.861	20 40	6.72	5.64	+1.08
02.12.1997	2450785.729	17 30	6.75	5.64	+1.11
	2450785.875	21 00	6.70	5.65	+1.05
03.12.1997	2450786.750	18 00	6.74	5.69	+1.05
	2450786.927	22 15	6.75	5.65	+1.10
07.11.1999	2451490.705	16 55	6.70	5.60	+1.10
	2451490.760	18 15	6.67	5.59	+1.08
	2451490.816	19 35	6.69	5.64	+1.05
08.11.1999	2451491.712	17 05	6.67	5.61	+1.06
	2451491.750	18 00	6.71	5.60	+1.11
	2451491.792	19 00	6.73	5.65	+1.08
	2451491.854	20 30	6.68	5.63	+1.05
11.11.1999	2451494.760	18 15	6.72	5.63	+1.09
	2451494.792	19 00	6.68	5.67	+1.01
	2451494.837	20 05	6.68	5.62	+1.06
12.11.1999	2451495.708	17 00	6.70	5.60	+1.10
	2451495.757	18 10	6.72	5.63	+1.09
	2451495.809	19 25	6.74	5.62	+1.12

arated by $0''.88$ (epoch 2000.0; orbit of Docobo & Costa 1990). It is worth noting that Edwards (1976) assigned aforementioned spectral types not on the basis of direct observations but by using an empirical method he elaborated to separate the components in close binary systems.

With Hipparcos (Perryman 1997) parallax $0''.02569$ (σ = $0''.00129$) we obtain a distance 39 pc for this star.

The third component C catalogued in ADS (Aitken 1932) is much more fainter (V=11.0) and distant ($160''$). It is unlikely to be related physically with the AB pair.

2. Observational data and reduction

2.1. Photometric data

Observations in standard UBVR bands were carried out in two sets: November 26–December 3, 1997 and November 7–12, 1999, using the 50 cm AZT-14 telescope of the Byurakan Astrophysical Observatory (Armenia) equipped with a direct current intensification photopolarimeter that works as a conventional photometer when the polarizer is removed.

Polarimetry was performed in UBVR bands but photometry in BV bands only. The standard deviation for polarimetric and photometric mesurements was about 0.1–0.2% and $0^m.02$–$0^m.03$, respectively. The star SAO 74365 was used as a standard. More details on the applied method and equipment, as well as reduction to the standard UBV system, can be found in Eritsian & Nersisian (1984).

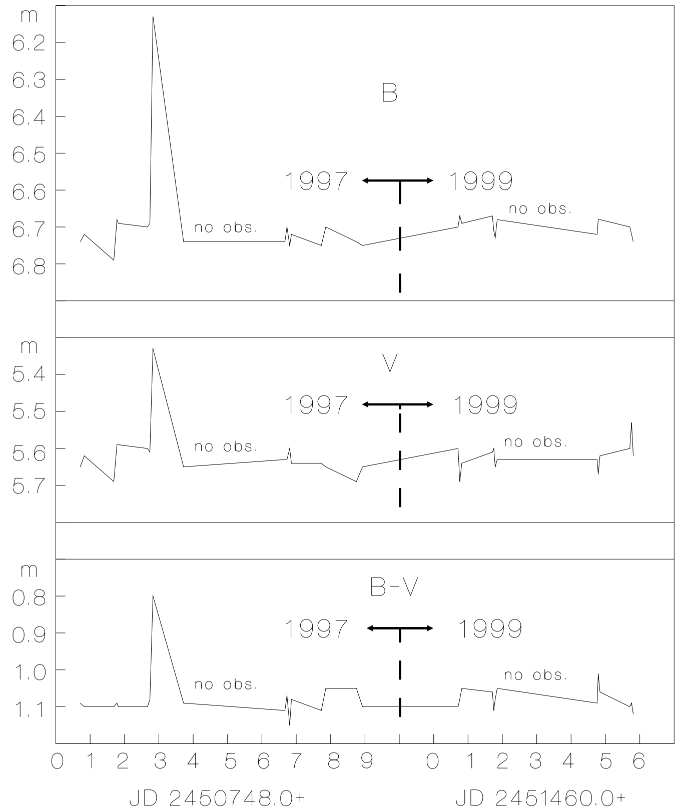

Fig. 1. Light curves and B-V index behavior for WDS 00550+2338. The dashed line separates two runs conducted in 1997 and 1999. Dates when observations were not carried out are indicated "n.o." (no observations, see data in Table 1).

A description of photometric observations and their results are presented in Table 1. Both conventional and Julian date, UTC time, apparent standard B and V magnitudes and B−V color index are given.

As mentioned above, two photometric runs were carried out – first in November 1997 when a brightness increase was detected for the first time, and second in November 1999 aimed to further monitor the star. The total observation time was about 27 hours. Photometric data obtained in 1997 were reported briefly in IBVS (Tamazian et al. 1998). To present a complete set of photometric data, observations in the 1997 run are included in Table 1 along with the results obtained in 1999. Photometric behavior of WDS 00550+2338 during these two sets of observations is shown in Fig. 1. No appreciable polarimetric signal was detected during the entire observational period.

2.2. Speckle interferometric measurements

Speckle interferometric measurements were carried out in September 21, 1999 using an intesified CCD (ICCD) camera of the Astronomical Observatory Ramon Maria Aller of the University of Santiago de Compostela, developed in cooperation with Special Astrophysical Observatory (Russia) and installed at the Cassegrain focus of the Spanish 1.52 m telescope at the Spanish-German Astronomical Center in Calar Alto (Spain).

The ICCD is based on the SensiCam CCD camera (manufactured by PCO Computer Optics GmbH, Germany) coupled to a 20 mm multialkaline photocathode 3-stage electrostatic image tube.

The observations consist of between 1000 and 3000 short exposures (electromechanical shutter synchronized with the detector allows selection of exposure times between 5 and 40 ms; up to 5 images per second can be stored on hard disk) depending on the seeing conditions and the object brightness. Each short exposure image is fully digitized at 12 bits per pixel and sampled by 512×512 pixels.

In the course of WDS 00550+2338 observations a 20^X magnification microobjective producing a scale $0''.0120$ per pixel at the detector plane was used. For precise scale determination we used a set of calibration stars with well known ephemerides.

After image correction for flat field and geometrical distortion, a standard speckle interferometric reduction technique was used. The last step is the power spectrum correction for photon noise as well as the circular cuts extraction from the set of spatial frequencies up to the cut-off. We assumed that the optical transfer function for each cut is constant, then fit a function based on the binary model, finally determining the precise separation and position angle.

The typical error of the measurement which depends on signal-to-noise ratio in the power spectrum was about $0''.01$ in separation and 1°in position angle. Geometrical aberration, mainly due to the image tube, was about 2%.

2.3. Speckle spectroscopy and spectrum

Speckle spectroscopy was employed to obtain separately the spectra of the primary and secondary stars. In our scheme a speckle image and its dispersed specklegram are simultaneously detected (Baba et al. 1994a). The cross-correlation of speckle images and dispersed specklegrams results in objective spectra with high spatial resolution (Baba et al. 1994b).

Speckle spectroscopic observations were conducted on September 10, 1998 at the San Pedro Martir Observatory in Mexico. The speckle spectroscopic camera was attached to the Cassegrain focus of the 1.5 m reflector. An interference filter of $\lambda = 642.5$ nm ($\Delta\lambda = 12.5$ nm) was used to detect speckle images, and dispersed specklegrams were formed with the use of a holographic blazed reflection grating (600 grooves/mm).

Two synchronized ICCDs, which were equipped with a micro channel plate (MCP), were emplyoed to detect speckle images and dispersed specklegrams, respectively. These ICCDs were operated at a video rate of 30 Hz. The effective exposure time of one data frame was reduced to 16ms after separating the odd and even fields of one video frame computationally.

Fig. 2 shows a reconstructed image (top) and its objective spectra (bottom) from 3920 data frames. The image was reconstructed by the shift-and-add method (Kuwamura et al. 1993) while objective spectra were reconstructed by the cross-correlation method under the assumption that the point spread function is the same as the imaging channel in the spectral reconstruction region. The secondary star spectrum yields displaced horizontaly relative to the primary exactly by the same distance as its direct image shown at the top. Each spectrum of both components was calculated by averaging 7 lines, which is the effective width of the reconstructed spectrum.

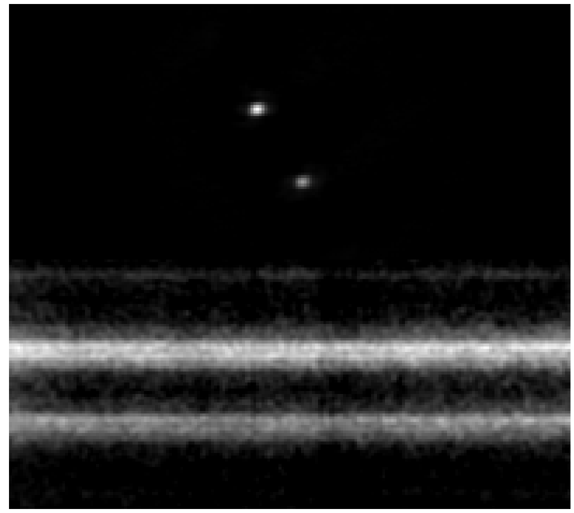

Fig. 2. Shift-and-add reconstructed image (top) and its spectra derived from the cross-correlation method (bottom). The spectral range is 639–695 nm for the primary star and 635–691 nm for the secondary.

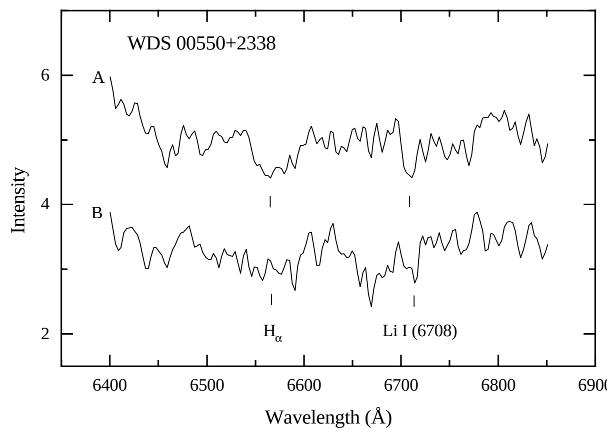

Fig. 3. Spectra of the primary (A) and secondary (B) components. Intensity is given in arbitrary units.

Fig. 3 show the spectra (intensity is given in arbitrary units) of the primary and secondary components, respectively. The wavelength range was limited to $\lambda = 645 - 685$ nm since the speckle images which served as a reference to the dispersed specklegrams were detected through the same filter, mentioned above.

The composite spectrum of WDS 00550+2338 was obtained on December 25, 1998 using the Boller & Chivens spectrograph attached to the 2.1 m telescope of the “Guillermo Haro” Observatory in Cananea, Mexico. A TK1024 (1024×1024 pix) CCD was used whose pixel size is 24 microns and readout noise $7e^{-1}$.

A 600 lines/mm grating was used, giving a dispersion of 30 A/mm with an effective instrumental spectral resolution of about 4 A.

All frames were reduced using the IRAF environment following standard bias substraction, flatfielding, cosmic rays bias removal and other usual proceedings. For flatfielding and wavelength calibration, halogen and He–Ar built-in lamps were used respectively, and standard stars were observed along with the target for calibration purposes. The spectrum is shown in Fig. 4 where several representative lines mentioned below in the text are marked.

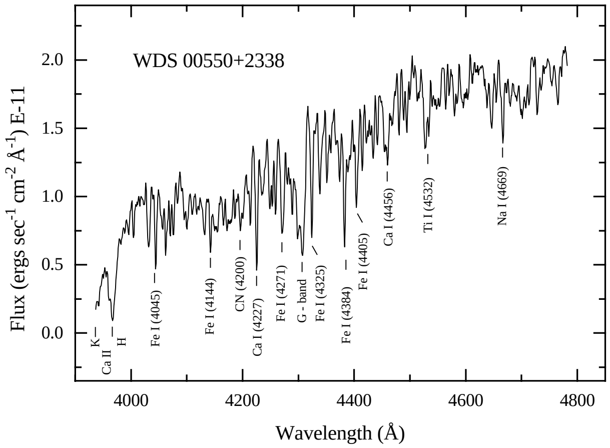

Fig. 4. Composite spectrum of WDS 00550+2338. Several representative lines are marked.

3. Results

3.1. Photometry

In Table 1 photometric data for WDS 00550+2338 obtained during both observing runs are given from which the mean values of apparent brightness in B ($6\overset{\text{m}}{.}66$) and V ($5\overset{\text{m}}{.}59$) bands as well as mean color index B−V = $1\overset{\text{m}}{.}07$ can easily be derived. They coincide with, or are very close to, those reported by Argue (1966), Lee (1970) and Jennens & Helfer (1975). Light curves of WDS 00550+2338 in B, V bands and behavior of B−V color index are shown in Fig. 1

A strong brightness increase on November 27, 1997 is clearly seen in Fig. 1 along with several weaker fluctuations occurring on different dates.

3.2. Spectral data

It is well known that the Harvard MKK system uses for classification of G–K type subdivisions progressive weakening of the ultraviolet part of the spectrum as well as strong G-band and metallic lines at G2–G5 and the appearance of TiO and MgH bands at K5. Given the spectral resolution of our spectrum and taking into account the spectral range, the most representative lines for classification purposes are H_δ, H_γ, CN band at 4200 A (all wavelengths in continuation are given in A), Ca I 4227, G-band, several strong Fe I lines (4045, 4144, 4271, 4325, 4384) etc.

Since our spectrum is not suitable for precise equivalent width calculation, we used rough estimations for the above mentioned lines to establish the spectral type, comparing our estimated values with those given by Jaschek & Jaschek (1987; 1995) for the same spectral type stars.

To assign the luminosity class, Balmer lines were used since their positive luminosity effect in G–K type stars (Jaschek & Jaschek 1987) is known, for example H_δ/Fe I 4071 and Sr II 4216/Fe I 4271 ratios as well as CN strength. On the other hand, Ca I 4227 has a negative luminosity effect amongst late G–K type stars.

With these criteria in mind, using a comparison with the Atlas of spectral tracings of Goy et al. (1995) and Atlas of representative stellar spectra of Yamashita et al. (1977) we conclude that the composite spectrum of 00550+2338 can be classified as K0 IV because:

1. The G-band is the strongest feature (except Ca II K line), even in comparison with a strong Ca I 4227 (which is very strong in the early K type) line, suggesting rather very early K type than late G.
2. The HI lines are still relatively well distinguishable, suggesting either late G or early K subtypes. The strongest lines are Ca II H and K (despite only one of them being seen), G-band, Ca I 4227 (which is stronger than G-band, indicating rather very early K than G type) and several Fe I lines are still relatively weak.
3. The relatively strong G-band is far from being dissolved (as in late K subtypes), an evidence in favor of very early K type.
4. There is no clear evidence for any strong molecular bands which would be indication of a late K type star.

However, the strength of Ca I 4227, several Fe I lines and weak CN band suggest certain characteristics of the K type seen in the composite spectrum. It is therefore resonable to suppose that one of the components belongs to G type while the other shows K type features.

It must be remembered that we are dealing with a composite spectrum which in reality represent none of the components separately. With the knowledge of its binary nature in mind, the spectrum may well be a mixture of an early G (very strong G-band) and not late K (no later than K5 when TiO and MgH bands appear) stars. Taking into account the brightness difference between components ($0\overset{\text{m}}{.}6$), the spectral types may differ even in the narrower range, namely G5−G8 and K3−K5.

As regards its luminosity class, there are clear indications of the subgiant branch suggested by above mentioned luminosity sensitive lines. At the same time, a comparison with both spectra of luminosity class III giants and normal dwarfs (Goy et al. 1995; Jacoby et al. 1984) shows that WDS 00550+2338 does not belong to any of these classes.

Table 2. Recent astrometric observations and residuals

Date	$\theta(^\circ)$	$\rho('')$	n	Observ.	Reference	$\Delta\theta(^\circ)$	$\Delta\rho('')$
1989.6135	285.6	0.722		CHARA	Fu et al. (1997)	+0.2	+0.000
1990.5550	287.0	0.820	3	Pri2,Lan1	Docobo et al. (1991)	−1.0	+0.08
1990.9070	288.4	0.737	7	USNO	Douglass et al. (1997)	−0.5	−0.006
1991.9540	291.0	0.750	2	USNO	Douglass et al. (1997)	−0.4	−0.009
1992.7500	292.4	0.764	5	USNO	Douglass et al. (1997)	−1.1	−0.009
1992.8830	293.1	0.800	2	Doc	Docobo & Prieto (1993)	−0.7	+0.03
1993.9196	296.3	0.778		CHARA	Hartkopf et al. (1997)	+0.0	−0.014
1994.9460	298.9	0.810	2	Doc	Docobo (1998)	+0.4	+0.000
1995.7627	300.6	0.810		CHARA	Hartkopf et al. (1997)	+0.3	−0.014
1997.6860	304.3	0.820	2	Pri	Ling & Prieto (1997)	+0.1	−0.04
1998.6953	307.4	0.860	1	Baba	This paper	+1.3	−0.0015
1999.7256	308.2	0.884	1	OA RMA	Docobo et al. (2001)	+0.2	−0.009

Such a conclusion is well supported by the speckle spectroscopy data showing rather different spectral characteristics of the components (see Fig. 3). The spatially resolved H_α line and the clearly seen Li I doublet at 6708 A first noticed in the composite spectrum by Luck & Challener (1995) suggest that the main component is a young G5-G8 star while the secondary has an almost unseen H_α and may correspond to the K1–K3 type.

Thus, speckle spectroscopy data not only confirm the presence of the Li I doublet but also allow us to attribute that feature clearly to the WDS 00550+2338 A.

3.3. Speckle measurements and orbital data

WDS 00550+2338 has now completed an entire period since its discovery in 1832 by W. Struve, and a number of orbits have been calculated for this bright pair. The most recent calculated orbit, and the one best fitting the observations, has a period P = 167.1 yrs. and semimajor axis a = $1''.002$ (Docobo & Costa 1990; see references therein for previous orbits). A number of measurements have been performed since this orbit was calculated, allowing evaluation of its quality. In Table 2, the date of observation, position angle, angular separation, number of observations, name of observer(s), reference source and the residuals of observations made since the last orbit was calculated, with respect to above mentioned orbit, are given.

From these data, one can see that the orbit is rather well determined and, probably only small improvements would be needed to obtain it definitively.

4. Discussion

We classified WDS 00550+2338 as a K0 IV star while it would be more correct to fix its position between G8–G9 and KO–K1 which, indeed, implies a rather small difference in temperature between real components, moreover when photometric and spectral methods agree in its value determination.

It is noteworthy that without knowledge of the star binarity, the spectral classification as well as the physical parameter calculation would be a complicated task because of certain irreconciliable details in the composite spectrum. To what extent this circumstance may have an influence on the derived astrophysical parameters can be illustrated by the following. Spinrad & Taylor (1969, 1971) included HD 5286 in their list of super metal rich (SMR) stars which they generally define as stars with metal abundance $[M/H] > +0.15$. Later, Faber et al. (1985), on the basis of the new data, suggest almost normal metallicity for this star. In both cases, the authors did not mention its binarity.

Obviously, any astrophysical parameter calculated for a close binary system does not represent any real star and may therefore contribute to the confusion when describing its physical properties, since it is mostly unclear what component they must be attributed to. It is especially important in the cases where the brightness difference between components is less than $1^{\rm m}.0$, which means that fainter component contribution may be more significant and clearly seen on the main background spectrum of the brighter one (Jaschek & Jaschek 1987).

On the basis of spectroscopic study, McWilliam (1990) obtained some model atmosphere parameters, in particular $T_{eff.} = 4780°$K for this star. Practically the same value ($4800°$K) has recently been obtained by Taylor (1999) who used the results of near infrared photometry, in particular V−K color index. In spite of different methods used to determine the temperature, both authors treated the star as a single object. Although our classification of K0 IV practically coincides with earlier classifications of Abt (1981) and Keenan & McNail (1989), who classified this star as K1 IV, we stress the uncertainty of the temperature and chemical abundance assignments, since they are attributed rather to a composite virtual object than to any of the real components (especially if photometric methods are used).

An exhaustive spectroscopic study of the WDS 00550+2338 chemical abundance must be noted (Luck & Challener 1995) not least because they first noticed the very important presence of the Li I 6708 doublet and derived its equivalent width.

Recent results of the differential photometry performed separately for the components A and B suggest they are dwarfs of spectral types K3 V and K5 V, respectively (Brummelaar et al. 1996). However, the absolute magnitudes M(A) = +3.1 and

M(B) = +3.7 calculated using Hipparcos parallax differ significantly from those of MS dwarfs belonging to the same spectral types (for which $M(V) > +6.0$; Schmidt-Kaler 1982) clearly suggesting a PMS location. Because of relatively small difference in brightness between components ($0\overset{m}{.}6$) it would be reasonable to suggest that they are both luminous subgiants, since these G and K type stars are located on the HR diagram within the same range ($M = +3$) of absolute magnitudes (Jennens & Helfer 1975; Schmidt-Kaler 1982). Thus, all aforementioned data support the suggestion that both components belong to the subgiants of luminosity class IV.

It must also be noted that the location of WDS 00550+2338 on the HR diagram coincides well with that of T Tau stars situated above the main sequence in a strip of G–K spectral types (Bertout 1989; Schatzman & Praderie 1993). In general, they are found 2 or 3 orders of magnitude above the main sequence at absolute magnitudes between +7 and +3 (Herczeg & Drechsel 1994).

Further strong evidence for the PMS status of a newly formed system is the presence of a Li I 6708 doublet in its spectrum (Luck & Challener 1995) as well as the inclusion of WDS 00550+2338 in the catalogue of stars with Ca II H and K emission cores (Glebocki et al. 1980). Unfortunately, in our spectrum, the K emission is situated on the limit of the spectral sensitivity and was therefore not reliably measured. Ca II doublet photoelectric flux measurements for this star are given by Duncan et al. (1991).

A very important clue to the age of WDS 00550+2338 A is the Li I 6708 absorption line which is usually only found in young objects, as it is depleted very rapidly in the stellar atmosphere, though no emission features are seen in its spectrum (Sterken & Jaschek 1996).

It is well known that one of the most characteristic properties of young PMS stars is their brightness variation which can be either irregular (and whose nature remains unclear) or regular (due to hot spot induced variations related to rotational period) (Bertout 1989; Bouvier & Bertout 1989; Herbst 1990; Simon et al. 1990; Sterken & Jaschek 1996). The time-scales of these variations differ significantly but we adopt the definition of flare-like events given by Gahm (1990) which refers to those variations similar to flares on flare stars over time-scales of several hours.

Photometric data given in Table 1 and shown in Fig. 1 not only confirm the variability of WDS 00550+2338 but also allow one to make certain suggestions regarding its nature. An overview of these data shows that variations in brightness and B$-$V color index were insignificant for the observational period but November 27, 1997, a sudden increase ($\Delta B = 0\overset{m}{.}56$, $\Delta V = 0\overset{m}{.}28$) was registered over the course of about 2 hours, which is evidence of its variability.

Apart from this sudden and relatively strong increase, another variation of smaller amplitude ($0\overset{m}{.}11$ in B and $0\overset{m}{.}10$ in V) was registered on November 26, 1997. This increase was higher than the 3σ level and may therefore be taken into account as a real fluctuation. Notice that both variations occured on the same time scale (of about two hours) on two consecutive nights (see data in Table 1). The strong flare occurred on November 27, 1997 and was preceeded by a weaker flare just a day before. It is unclear though, to what component the activity must be attributed.

As it seen from Fig. 1, the B$-$V color index becomes more blue during the strong event but remained unchanged throughout the course of the weaker one.

A second observation was carried out in 1999 to follow WDS 00550+2338 photometric behavior and detect new changes in brightness. The results showed no significant brightness or color index variations during that period.

Taking into account the spectral type of the star as well as the seemingly irregular character of the detected variations, one may suggest that these changes are similar to the flare-like events (Gahm 1990) observed in young PMS stars. However, additional long-term monitoring seems necessary to clarify the nature of the variability.

Finally, the total A+B mass of the pair, $2.1M_{\odot}$, has been derived using semimajor axis and period values obtained by Docobo & Costa (1990) and the Hipparcos parallax value. The use of better orbit and precise parallax value allowed us to improve significantly the total mass value, $3.85M_{\odot}$ obtained by Stefensson & Sanwall (1969) on the basis of the orbit calculated by Muller (1957).

According to Schmidt-Kaler (1982), a K0 III–IV star mass is about $1.0M_{\odot} - 1.1M_{\odot}$ while a K5 dwarf has a mass less than $0.8M_{\odot}$. Under the assumption that both components are dwarfs (as suggested by Brummelaar et al. 1996), the total mass of the system should be about $1.5M_{\odot}$, discordant (within the estimated error bar of our mass determination equal to $0.3M_{\odot}$) with $2.1M_{\odot}$ value obtained in the present study.

Thus, both luminosity and total mass estimations support the above main sequence location of the star, with a variability similar to the flare activity of young PMS stars.

Acknowledgements. Authors thank Dr. O. Martinez (INAOE) for assistance in observations on 2.1 m telescope at the Cananea Observatory.

References

Abt H.A., 1981, ApJS 45, 437

Aitken R.G., 1932, New General Catalogue of Double Stars. Carnegie Institution of Washington Publ. No. 417, vol. I, p. 68

Argue A.N., 1966, MNRAS 133, 475

Baba N., Kuwamura S., Norimoto Y., 1994a, Appl. Opt. 33, 6662

Baba N., Kuwamura S., Miura N., Norimoto Y., 1994b, ApJ 431, L111

Bertout C., 1989, ARA&A 27, 351

Bouvier J., Bertout C., 1989, A&A 211, 99

Brandner W., Alcala J., Kunkel M., Moneti A., Zinnecker H., 1996, A&A 307, 121

Brummelaar T.A., Mason B.D., Bagnuolo W.G. Jr., et al. 1996, AJ 112, 1180

Docobo J.A., 1998, A&AS 130, 117

Docobo J.A., Costa J.M., 1990, PASP 102, 1400

Docobo J.A., Ling J.F., Prieto C., Lanchares V., 1991, A&AS 91, 229

Docobo J.A., Prieto C., 1993, A&AS 100, 641

Docobo J.A., Tamazian V.S., Balega Yu.Yu., et al., 2001, A&A accepted
Douglass G.G., Hindsley R.B., Worley C.E., 1997, A&AS 111, 289
Duncan D.K., Vaughan A.H., Wilson O.C., et al., 1991, AJ 76, 383
Edwards T.W., 1976, AJ 81, 245
Eritsian M.A., Nersisian S.E., 1984, Astrofizika 20, 355
Evans D.S., 1977, In: Mirzoyan L.V. (ed.) Proc. of Symposium: Flare stars. Publ. House of the Armenian Acad. of Sci., Yerevan, p. 40
Faber S.M., Friel E.D., Burstein D., Gaskell C.M., 1985, ApJS 57, 711
Fu H.H., Hartkopf W.I., Mason B.D., et al., 1997, AJ 114, 1623
Gahm G.F., 1990, In: Mirzoyan L.V., Pettersen B.R., Tsetkov M. (eds.) Proceedings of IAU Symposium 137: Flare stars in star clusters, associations and the stellar vicinity. Kluwer Academic Publishers, Dordrecht, The Netherlands, p. 193
Ghez A.M., Weinberger A.J., Neugebauer G., Matthews K., McCarthy D.W. Jr., 1995, AJ 110, 753
Glebocki R., Musielak G., Stawikiowski A., 1980, Acta Astron. 30, 453
Goy G., Jaschek M., Jaschek C., 1995, An Atlas of stellar tracings. Geneva Observatory, Geneva
Hartkopf W.I., McAlister H.A., Mason B.D., et al., 1997, AJ 114, 1639
Herbst W., 1990, In: Mirzoyan L.V., Pettersen B.R., Tsvetkov M. (eds.) Proceedings of IAU Symposium 137: Flare stars in star clusters, associations and the stellar vicinity. Kluwer Academic Publishers, Dordrecht, The Netherlands, p. 169
Herczeg T.H. Drechsel H., 1994, In: Roth G.D. (ed.) Compendium of practical Astronomy. vol.3, Springer Verlag, Berlin, p. 107
Jacoby G.H., Hunter D.A., Christian C.A., 1984, ApJS 56, 257
Jaschek C., Jaschek M., 1987, The Classification of Stars. Cambridge Univ. Press, Cambridge
Jaschek C., Jaschek M., 1995, The behavior of chemical elements in stars. Cambridge Univ. Press, Cambridge
Jennens P.A., Helfer H.L., 1975, MNRAS 172, 667
Keenan P.C., McNeil R.C., 1989, ApJS 71, 245
Kukarkin B.N., Kholopov P.N., Artiukhina N.M., et al., 1982, New Catalogue of Suspected Variable Stars. Nauka Publ. House, Moscow
Kuwamura S., Baba N., Miura N., Hege E.K., 1993, AJ 105, 665
Lee T.A., 1970, ApJ 162, 217
Ling J.F., Prieto C., 1997, Astron. Nachr. 318, 365
Luck R.E., Challener S.L., 1995, AJ 110, 2968
McWilliam A., 1990, ApJS 74, 1075
Muller P., 1957, J. Observateurs 40, 50
Perryman M.A.C., 1997, (sci.coordinator) The Hipparcos and Tycho Catalogues. vol.5, ESA Publishing Division, Nordwijk, The Netherlands, p. 86
Reipurth B., Zinnecker H., 1993, A&A 278, 81
Schatzman E.L., Paderie F., 1993, A&A Library Series – The Stars. Springer Verlag, Berlin, p. 257
Schmidt-Kaler T., 1982, In: Landolt-Bornstein. New Series, vol. 2b, Springer, Berlin, p. 18
Simon M., 1995, Ap&SS 223, 45
Simon T., Vrba F., Herbst W., 1990, AJ 100, 1957
Simon M., Chen W.P., Howell R.R., Benson J.A., Slowik D., 1992, ApJ 384, 212
Simon M., Ghez A.M., Leinert Ch., 1993, ApJ 408, 33
Spinrad H., Taylor B.J., 1969, ApJ 157, 1279
Spinrad H., Taylor B.J., 1971, ApJ 163, 303
Stefensson S.B., Sanwall N.B., 1969, 74, 689
Sterken C., Jaschek C., 1996, in "Light curves of variable stars", Cambridge University Press
Tamazian V.S., Docobo J.A., Chavushian V.O., Vlasyuk V.V., 1997, ASSL Ser. 223, 27
Tamazian V.S., Docobo J.A., Melikian N.D., 1998, IBVS 4604, 1
Tamazian V.S., Docobo J.A., Melikian N.D., 1999, ApJ 513, 933
Taylor B.J., 1999, A&AS 134, 523
Yamashita Y., Naria K., Norimoto Y., 1977, An atlas of representative stellar spectra. Univ. of Tokyo Press, Tokyo