

SAO 64632

A new variable star in the field of U CrB

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Abstract: A light curve of the dwarf K star SAO 64632 (BD +32 2572), in the same field as U CrB, is presented in this paper. Data was obtained using the 7.5-cm telescope at the Cáceres Astronomical Observatory (Cáceres, Spain) equipped with a Starlight Xpress MX516 CCD. The present light curve (in V band) and those obtained by HIPPARCOS (in B_T and V_T band) are all analyzed: the results show that SAO 64632 is a variable star of low amplitude (almost 0.18 magnitude) with a period near to 9.24 days.

Name of the object: SAO 64632, BD +32 2572, HIP 75011

Equatorial coordinates: R.A.= 15h 19m 40.14s DEC.= 31° 50' 33" (Equinox: 2000.0)

Observatory and telescope: Cáceres Astronomical Observatory, Cáceres (Spain), 7.5-cm achromatic refractor

Detector: Starlight Xpress MX 516 camera, 512 x 290 pixels, 16 bits

Filter: V Johnson

Comparison star: SAO 64632 (HIP 75011) for U CrB

Check stars: TYC 2563-605-1, TYC 2563-1152-1 (BD +32 2567), TYC 2563-1060-1

Availability of the data: Upon request to fviolat@yahoo.es

Type of variability: BY (BY Dra: stars with 'starspots' rotating with the star), L (unstudied variable stars with slow light changes) or IB (poorly studied irregular variables of intermediate [F-G] to late [K-M] spectral type).

The variability of SAO 64632 (BD +32 2572 and HIP 75011), a high proper-motion star (LTT 14557 or PPM 78506), has been discovered during a programme to study, discover and/or classify new variables, using CCD observations of stellar fields with a small telescope. In this case the star was the eclipsing variable U CrB (α : 15h 18m 11.35s, δ : +31° 38' 49.42", mag.: 7.82 V , period: 3.4522053 days), using SAO 64632 ($V = 8.8$, Sp. K0 V) as comparison star and TYC 2563-605-1 ($V = 9.55$), TYC 2563-1152-1 ($V = 10.52$, Sp. G5) and TYC 2563-1060-1 ($V = 10.30$) as check stars (B, C and D in our CCD chart, Figure 1).

The observations were done over 47 days (but 33 nights) between 2006 August 30 and October 15 (HJD 53978 to 54024), using a CCD camera (Starlight Xpress MX516, 512 x 290 pixels, 16 bits, field of view: 36' x 24') attached to the focus of the 7.5-cm refractor (focal length = 500 mm) at Cáceres Astronomical Observatory, Cáceres (Spain), with a V Johnson filter. The exposure time was 40-45 s, depending on the transparency; the frames were corrected for standard dark and flat fielding, and were then processed with the microcomputer-based aperture photometry software "AIP₄WIN". Because the signal-to-noise ratio for SAO 64632, a presumably nonvariable star, are above 50 the photometric precision was below 0.04 magnitude.

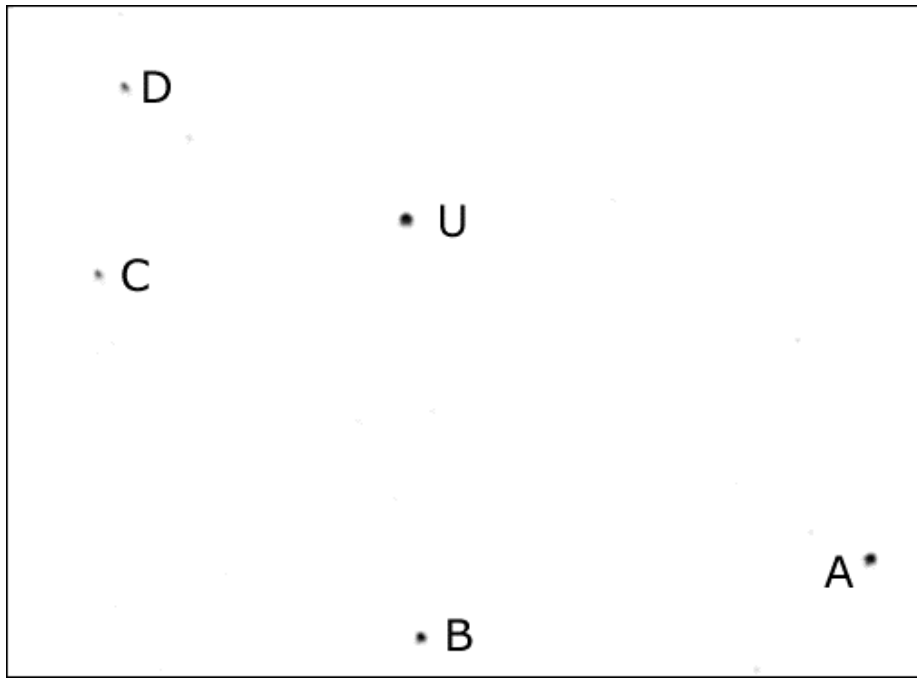


Figure 1. CCD finding chart made from the authors of the variable U CrB (U), the comparison star (A), and the check stars (B, C and D). Field of view: 36' x 24'; North down, East to the right. Limiting magnitude: ~13.

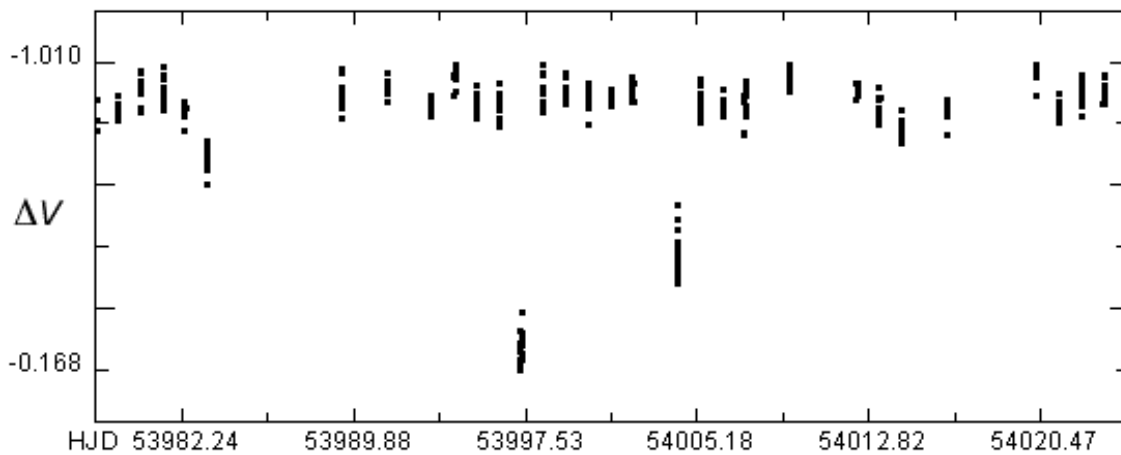


Figure 2. Light curve, in V band, of U CrB from our 395 CCD measurements: a strange “oscillation” (as abnormal scatter) between eclipses, can be observed.

From 402 CCD frames over 395 observations of U CrB, an EA eclipsing star, the following was taken: the CCD finder chart (with labelled stars) is shown in Figure 1 and the light curve is shown in Figure 2. The magnitudes were determined relative to SAO 64632, whose constancy during the run was confirmed using TYC 2563-605-1, TYC 2563-1152-1 and TYC 2563-1060-1. In Fig. 3 we can see a strange “oscillation” between eclipses because the comparison star is really variable; curiously the same periodical “oscillation” appears in the light curves of the 3 check stars (Figure 4).

The measured amplitude was in the range 0.21 to 0.40 magnitude, including the random errors: the scatter increases and widens for the low bright stars TYC 2563-1152-1 and TYC 2563-1060-1 (V 10.52 and 10.30 magnitudes respectively).

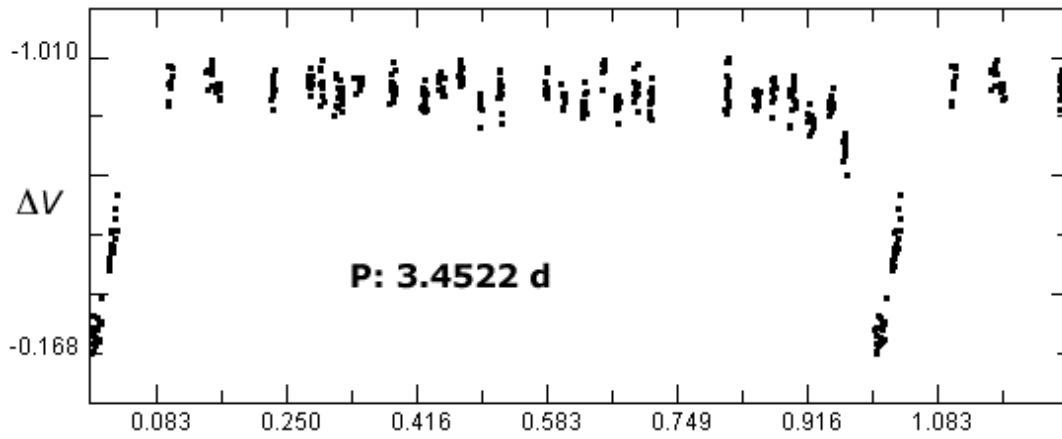


Figure 3. Light curve, in V band, of U CrB from our 395 CCD measurements, folded with the official period; amplitude measured: 0.842 magnitude. One can see the periodical, and sinusoidal, oscillations in the time.

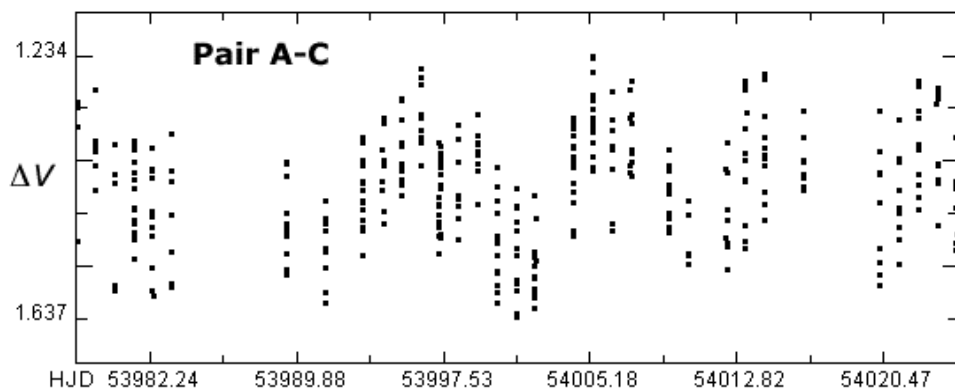
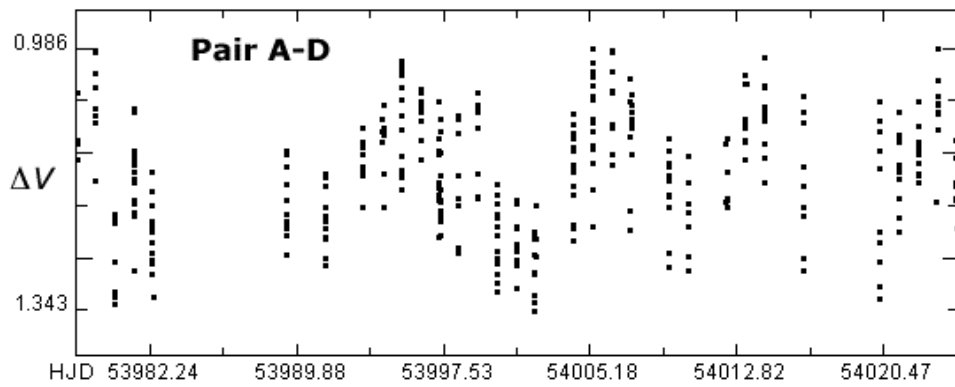
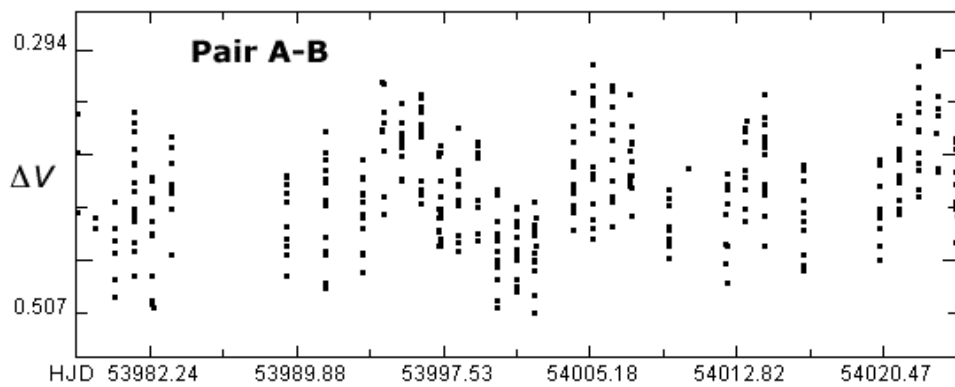


Figure 4. Light curves of check stars: TYC 2563-605-1 (pair A-B), TYC 2563-1060-1 (A-D) and TYC 2563-1152-1 (A-C) with the same and identical, periodical, quasi-sinusoidal “oscillations”.

The analysis of the photometric data was performed by means of the program “Análisis de Variabilidad Estelar” AVE (written by Rafael Barberá, Grupo de Estudios Astronómicos, G.E.A., <http://www.astrogea.org/soft/ave/aveint.htm>) using the Scargle algorithm (Scargle, 1982); the search in the interval 1-60 days (Fig. 5) yields a period of 9.200 days for TYC 2563-605-1, 9.211 days for TYC 2563-1152-1 and 9.243 for TYC 2563-1060-1 (average period: 9.218 days).

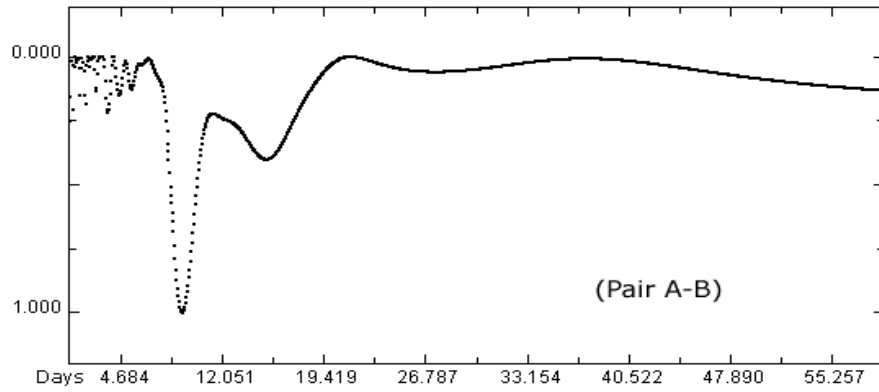


Figure 5. Scargle periodogram obtained for the interval 1-60 days of the pair A-B; period found: 9.20 days.

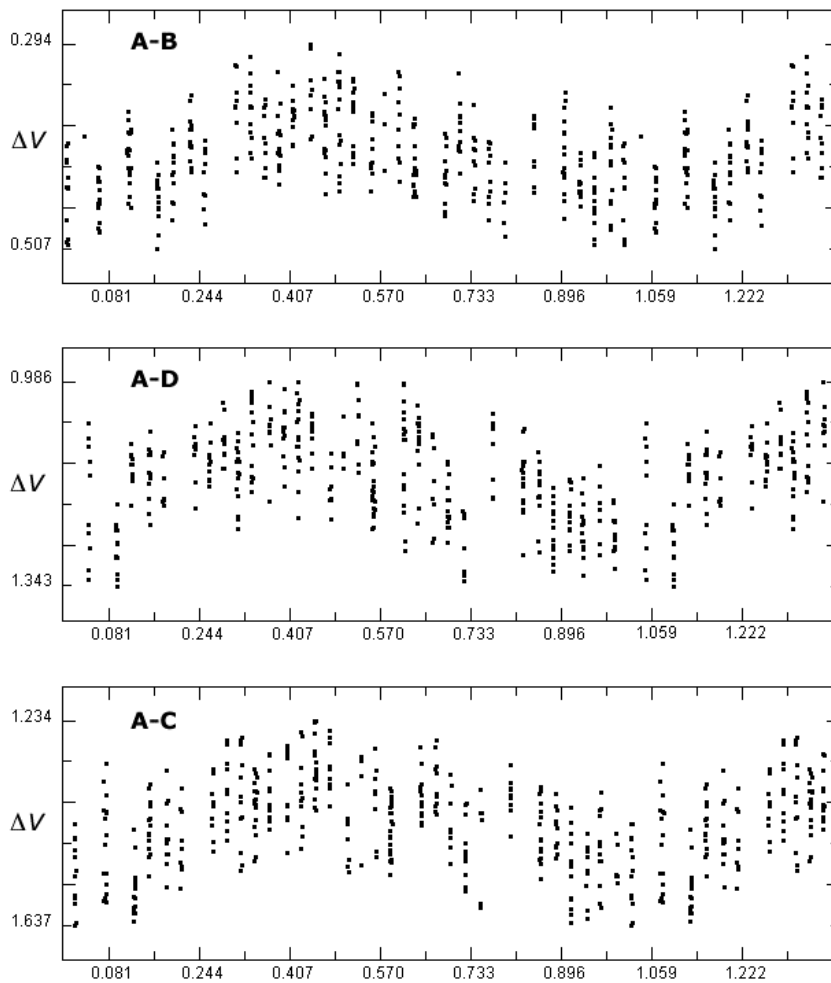


Figure 6. Light curves of check stars (pairs A-B, A-D and A-C) folded with the average period (9.218 days).

In Fig. 6 we can see the light curves of pairs A-B, A-D and A-C folded with the average period found (9.218 days). In Fig. 7 we can see the light curves of pairs D-A and D-C using D (TYC 2563-1060-1) as comparison star: the dashed lines are the mean magnitudes for each star. New period found for this 379 measurements: 9.130 days.

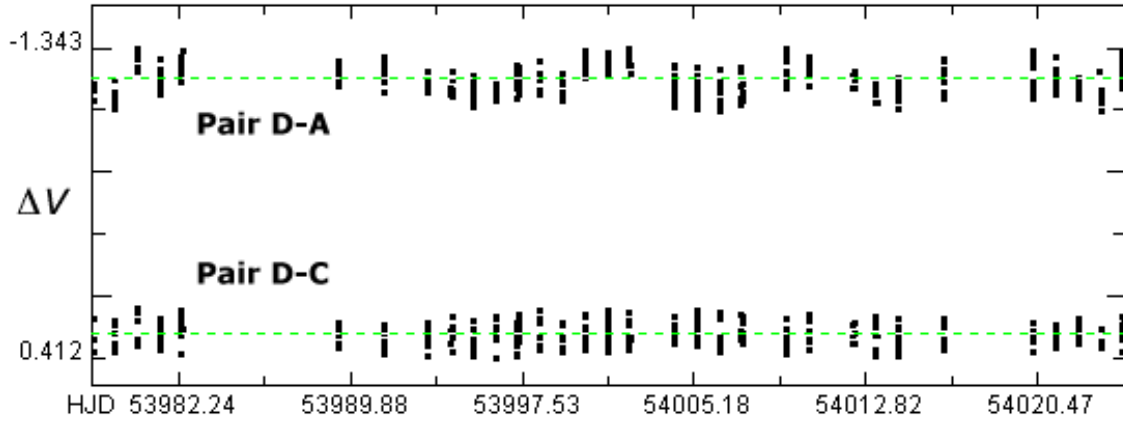


Figure 7. Light curves of pairs D-A and D-C using now D (TYC 2563-1060-1) as comparison star: the dashed lines are the mean magnitudes for each star.

Photometric variability of SAO 64632 was detected by the *Tycho* instrument during the *Hipparcos* project (Fig. 8), but no studies on variability have been published to date.

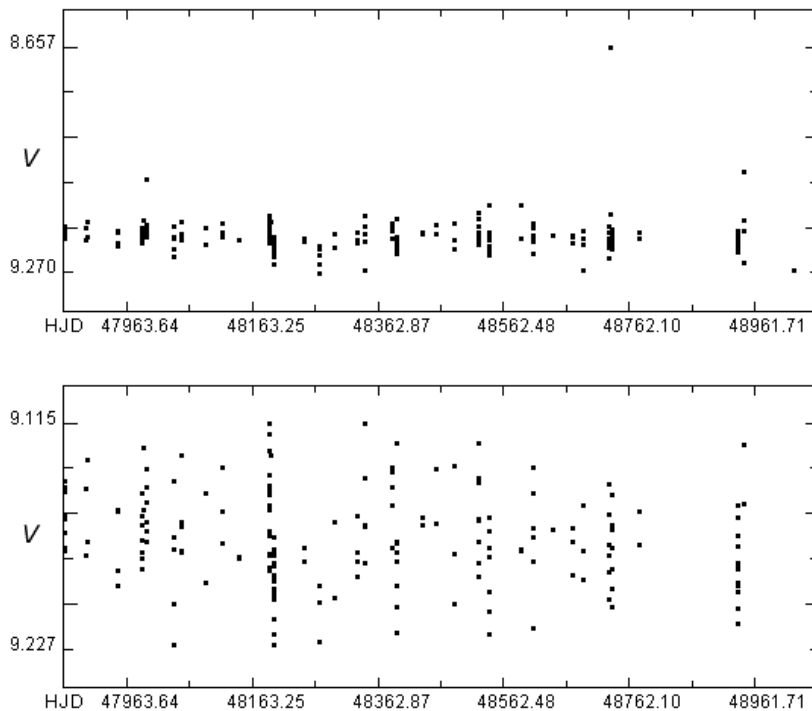


Figure 8. The *Hipparcos* data collected between HJD 2447863 and 2449061: all the data (panel a), and only accurate data (panel b) cleared by the authors.

Finally, Figure 9 graphs of the *Hipparcos* data (191 measurements) folded to the period derived for SAO 64632 from this data (9.323 days). The paucity of *Hipparcos* data (the four-year

lifetime of the satellite ended in August 1993), the bad temporal coverage (the *Tycho* observations of any particular star are very unevenly distributed in time) and the high noise of the V_T and B_T data account for the unsolved variable status of SAO 64632 in the *Hipparcos* catalogue.

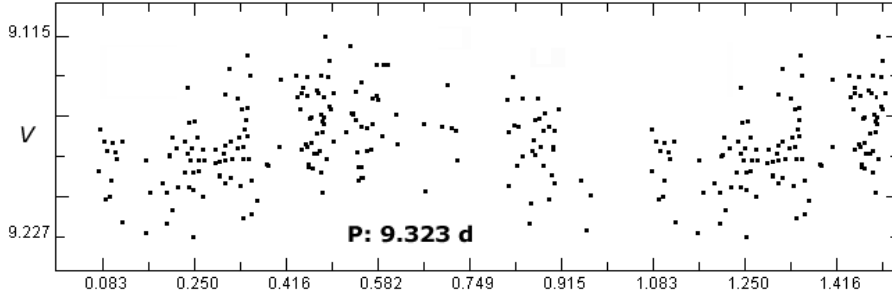


Figure 9. The *Hipparcos* data (191 points) folded with a period equal to 9.323 days.

Some physical data about SAO 64632 taken from SIMBAD or Strassmeier et al. (2000) are: spectrum = K0 V; parallax: $0.02227'' \pm 0.00123''$; distance: 145 y.l.; radial velocity: -26.6 ± 0.4 km s⁻¹; colour index $B-V$: 0.83; T_{eff} : 5210 K and M_v : 5.9. This dwarf K star with a large annual proper motion (LTT 14557 or PPM 78506), is a member of the “Hyades supercluster”. The projected rotational velocity, $V \sin i$, measured by Strassmeier et al. on the same night was 6.2 km s⁻¹ and 10.1 km s⁻¹.

DISCUSSION

Fekel (1997) measured 133 bright stars with spectral types of F, G or K from *The Bright Star Catalogue*: the projected rotational velocities of 24 stars of spectral types K0 V to K7 V are in the range 0.6 km s⁻¹ to 3.9 km s⁻¹, showing moderately slowly rotating stars (periods > 14 days). The work of Radick et al. (1987), high-precision differential b, y photometric observations, shows that the rotation periods of lower main-sequence Hyades stars (like SAO 64632, sp. K0 V) increase from about 5 days at $B-V = 0.55$ (~F8 V) to about 13 days at $B-V = 1.25$ (~K5 V), and the rotational velocities decline smoothly from about 11 km s⁻¹ to 4 km s⁻¹ over this color range.

From the Strassmeier et al. velocities the rotation period for SAO 64632 are in the range of 6 to 10 days. If the photometric periods (*Hipparcos* and ours) agrees with this range, then the low-level variability measured (~0.11 mag. *Hipparcos*, but 0.21 mag. from our best measurements: 0.17 ± 0.04 mag.) can be attributable to starspots in a moderately fast rotating star. A periodic (rotational) signal has been detected in the intraseasonal H+K variability of HD 1835 and HD 25998 (Baliunas et al., 1983), both members of the Hyades “moving group”: HD 1835, a normal solar-type dwarf star (G2 V), shows low-level photometric variability (3%-4%).

It is particularly important to remember that low-level photometric variability is a ubiquitous characteristic of Hyades stars later than spectral type F8 V: twenty-four of these stars were observed at Lowell Observatory between 1982-1984 and, without exception, all were found to be variable (Radick et al., 1987).

The sinusoidal shape of the four folded light curves, one from *Hipparcos* and three from ours data, suggests that SAO 64632 is a BY Dra variable star (a type characterised by showing low [0.01 to 0.5 magnitude] visual amplitudes over intervals varying from a fraction of a day up to about 120 days), and the surface activity is extended covering a significant fraction of the stellar surface. Stellar rotation may be periodic (9, 10 or 11 days), but the modulation signal produced by dark spots marking a stellar surface is not: the appearance and disappearance of spots at different longitudes will affect the amplitude, period and waveform of the light curves (as in SAO 64632).

In 2006 intensive photometric observations were obtained over 33 nights and 47 days (Violat & Violat, 2006); there is no doubt that we have been lucky: one (possibly three) of the field stars were found to be variable. We need more accurate photometric observations, in a future campaign (2007), to adequately classify this new variable star.

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