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AS 325: DISCOVERY OF ECLIPSES IN AN ENIGMATIC EMISSION LINE STAR

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Since the discovery in 1948 of its unusual spectrum (Merrill and Burwell, 1950), the history of AS 325 has been full of mystery. The complex spectrum prevented unambiguous classification and every paper published made a different claim about its nature. In that first reference it was classified as an F star with emission lines. In 1972 an A7Ia+pec. spectral type was published by Stock and Wroblewski (1972). Sanduleak and Stephenson (1973) presented a low dispersion spectrum obtained in 1967 showing only the strongest emission lines and the star was again classified as Fe pec., based upon the presence of a strong K-line in absorption. It's also type F in Henize (1976) from observations made between 1949 and 1951. Lutz (1977) found a G8III spectral type from the absorption lines in observations taken in 1975 and 1976, this survey having a far better dispersion than the previous ones. Bopp and Howell (1989) first mentioned the possibility of AS 325 being a binary system and proposed it as an analog of XX Oph mainly due to the FeII emission features. [It is interesting to note that strong FeII lines in emission are reported in the spectrum of some symbiotic stars like the VV Cep system WY Vel (Sanduleak and Stephenson, 1973), which is classified as ZAND in the GCVS (Kholopov et al., 2004).] Observations from 2001 (Pereira et al., 2003) showed the continuum increasing toward the blue and the star was consequently classified as a peculiar Be object.
Finally, from recent observations, a new model has been published by Cool et. al (2005) proposing a binary system made up of a Be star and a K2.5III cool companion.

There are ASAS-3 V band observations (Pojmanski, 2002) ranging from February 14, 2001 to the present, and the ASAS variability catalogue lists it as MISC-type (see Pojmanski and Maciejewski, 2004, for a more detailed description of ASAS variability types) with a period of 169.635 days (Pojmanski and Maciejewski, 2004b). However, no trace of this published period was found in a period analysis performed with AVE (Barberá, 1999). On the contrary, the ASAS-3 data show that AS 325 is a long period eclipsing binary which also shows out of eclipse variations. There are at least three types of variability detectable in the light curve:

* Algol-type eclipses (∼0.7 mag. deep in V), shown in Figure 1.
* A mean magnitude long term brightening of 0.6 magnitudes (from V= 10.6 to V= 10.0), as shown in Figure 2.
* Some flickering activity with 0.1 mag. peaks showing a quasi-cyclicity of ∼20 days, especially during the first three years of observations when the star was fainter. These variations presumably come from the Be star and are shown in Figure 3.

The light curve also exhibits some low amplitude stochastic variability.

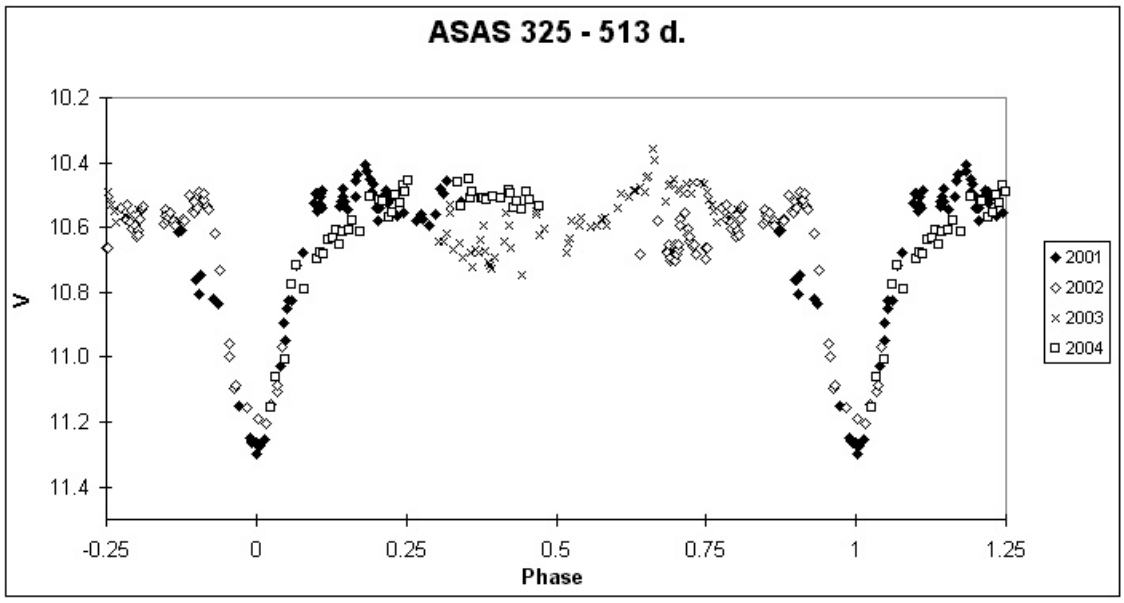

Figure 1. Light curve of AS 325 with a period of 513 days using ASAS-3 observations. The long term secular brightening has been detrended.

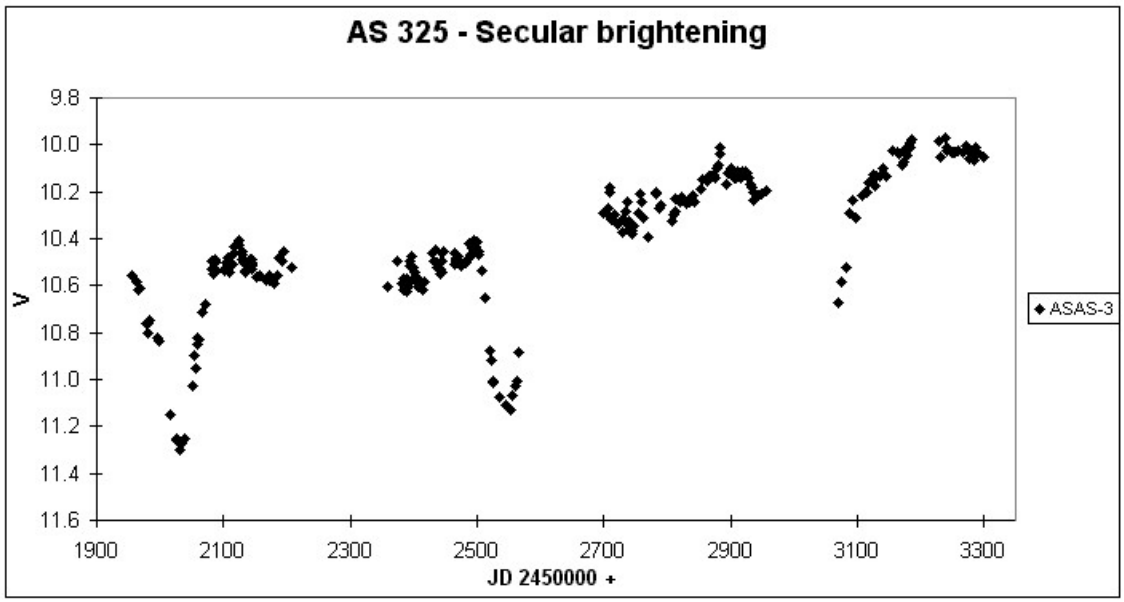

Figure 2. Light curve of AS 325 between 2001 and 2004 using ASAS-3 data.

This system was included by Munari and Zwitter (2002) in their Table 1 in a subset called "possibly symbiotic stars or closely related objects" published in their Atlas of Symbiotic Stars. The ASAS-3 based eclipsing light curve fully confirms the binarity. The period of 513 days is also fairly typical of known eclipsing symbiotic stars. A couple of examples are AR Pav, 604 days (Skopal et al., 2001) and V1413 Aql, 434 days (Munari, 1992). The long term brightening may represent changes in the accretion rate in this interacting binary.

The lack of photometric observations in the past makes further analysis very difficult. It looks like AS 325 hasn't shown signs of previous strong activity at least visually (see catalogues in VizieR for more). The New Suspected Variables Supplement (NSVS) (Kazarovets et al., 1998) classifies it as a slow irregular variable (L:) ranging from 9.6 to 10.2p. Tycho epoch photometry (Hog et al., 1997) shows almost no variability between 1990 and 1992, and interestingly with gaps in the observations exactly at the times of eclipse. Tycho-2 (Hog et al., 2000) derived mean magnitude is V= 10.08 with a $B-V$ of 0.67.

The emission line spectrum and the colors indicate that the hot star is the primary and during eclipse the cool giant is occulting it partially, according to the light curve shape. The approximate duration of the eclipses is 86 days but both duration and light elements are only approximate since the shape of the light curve is affected by the intrinsic variability. The 2002 eclipse was sharper than that of 2001. There are no signs of a secondary eclipse but the observations are scarce. ASAS-3 only covered the mideclipse in 2001 and 2002 and shows minima around HJD 2452031.5 and 2452543.5.

Light elements for AS 325:

$$\begin{array}{c} \text{Min I} = \text{HJD2452031} + 513\text{d} \times \text{E} \\ \qquad\qquad\quad \pm 3 \quad\ \pm 4 \end{array}$$

In Figure 4 spectral measurements are plotted against the phased light curve suggesting that all spectra but those taken by Sanduleak and Stephenson (1973) in August 3rd and 6th, 1967 (phase 0.98), were taken at maximum light. In Bopp and Howell (1989) is noted that Sanduleak and Stephenson's (1973) spectrum showed the K-line stronger and broader than in their March 27th, 1985 (orbital phase 0.54) spectrum. This is consistent with the cool giant being in front of the hot star during primary eclipse. The early spectral type suggested for the cool component is not common for a symbiotic system but neither is it unknown. For instance, AG Dra consists of a K3 giant and a white dwarf with a similar orbital period of 550 d. (Friedjung et al., 2002). It has even been called a "yellow symbiotic" (Cunha et al., 2000). Also, TX CVn consists of a K5 giant orbiting a B9shell star (Kenyon and Garcia, 1989).

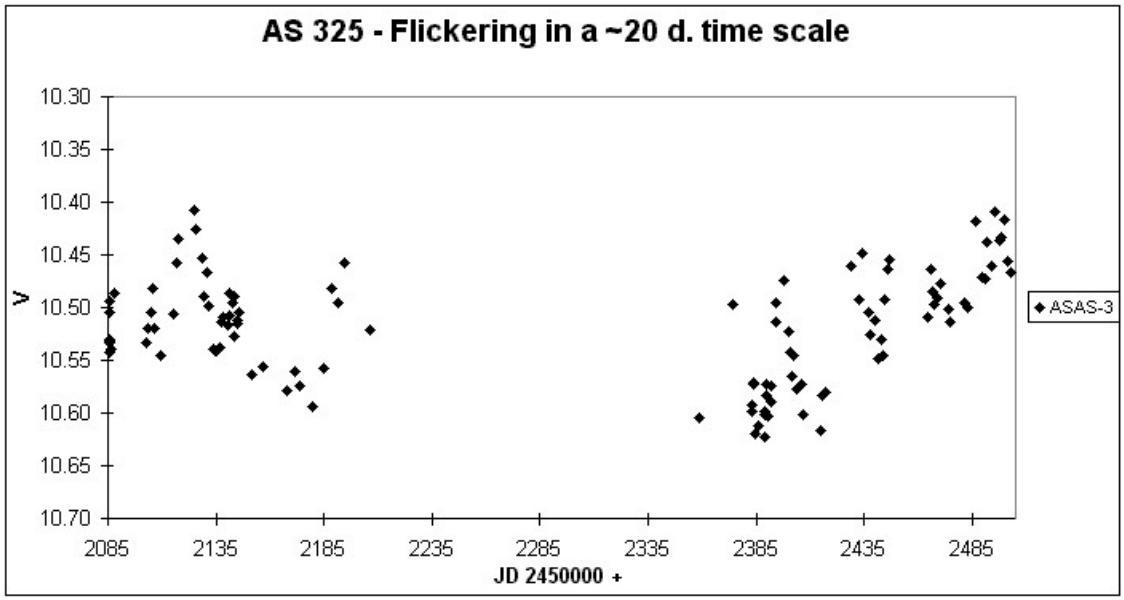

Figure 3. Light curve of AS 325 during 2001 and 2002 showing short term variability with a quasi-cycle length of around 20 days.

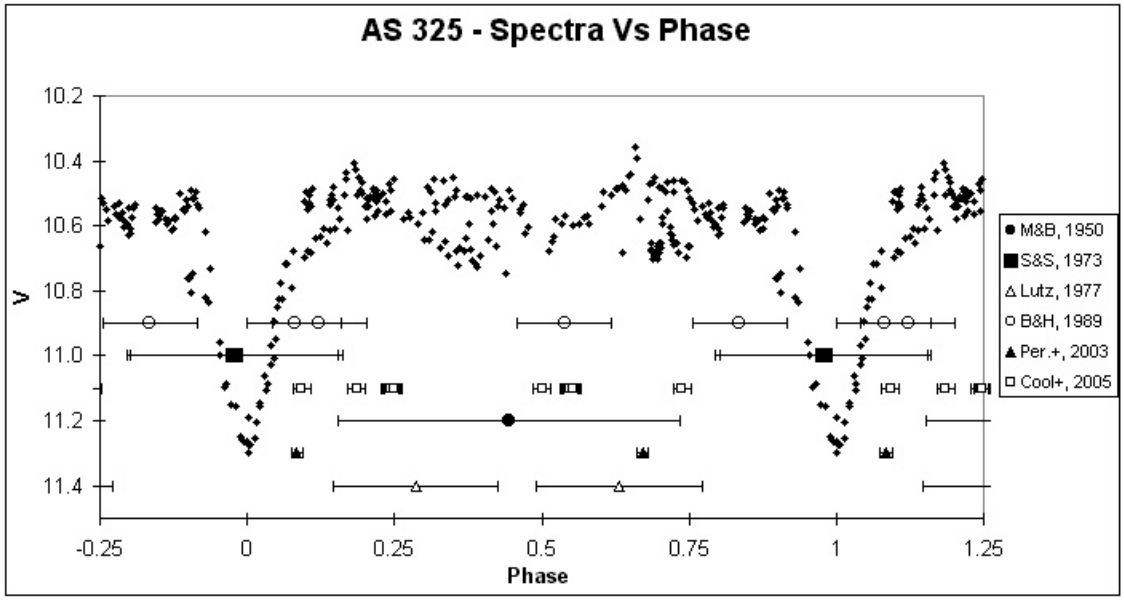

Figure 4. The same light curve is presented in Fig.1 but also showing the dates when spectra were taken. The reference dates are for the publications mentioned in this paper. The error bars show the uncertainty in phase units.

Call for observations

The upcoming 2005 eclipse is well placed in time to ensure complete coverage of the primary eclipse both photometrically and spectroscopically. Table 1 shows the predicted times of first and last contact as well as of mideclipse. Given the uncertainty in the elements and the intrinsic variability, it is important to start observing several days before the predicted time of ingress. Note that the 2006/7 event will take place right in the seasonal gap when Sagittarius is in conjunction with the Sun. High dispersion spectroscopy being undertaken for the first time during an eclipse will shed light on the nature of the components of AS 325, helping to classify and further understand this interesting and somewhat uncommon system.

Table 1 - Predictions for the next eclipses of AS 325 based on a 513 days period of 86 days eclipse duration.

Year	Ingress	Mideclipse	Egress
2005	June 5	July 18	August 30
2006/7	October 31	December 13	January 25
2008	March 27	May 9	June 21

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ERRATUM FOR IBVS 5570

In the list of new eclipsers GSC 1294-1710 should be GSC 1294-0710.

S. Otero