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ABSOLUTE DIMENSIONS OF THE OUTBURSTING WD IN THE SYMBIOTIC NOVA AS 338 FROM MAPPING OF THE 2005 ECLIPSE

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Abstract. The total eclipse of the symbiotic nova AS 338 occurred during the summer of 2005 was monitored in detail in the $UBVR_CI_C$ passbands, resulting in accurate multicolor eclipse profiles. These eclipse profiles are modeled to derive absolute dimensions and properties of the inflated and outbursting WD component and to compare them with theoretical expectations.

Key words: stars: binaries: symbiotic – stars: individual (AS 338)

Symbiotic stars are interacting binaries in which material is transferred from a late-type giant star (LTG) to a hot compact companion, generally a WD. Stable burning at the WD surface of the H-rich material accreted from the LTG is probably powering a sizable fraction of known symbiotic stars (cf. Sokoloski 2003). These objects frequently undergo powerful outbursts, whose amplitude can attain several magnitudes in the B passband, and the typical scenario for such events involves a thermonuclear runaway in a non-degenerate accreted envelope, the expansion velocity of which generally never reaches the escape value. Such types of outbursts are well described by expanding and cooling of the WD which becomes similar to A–F giant or supergiant. This lasts for months or years before the return toward the quiescent state. Only a tiny fraction of such systems undergoing non-degenerate outbursts are also total eclipsing systems and they offer the unique opportunity to follow the evolution in radius and temperature of the expanded white dwarf (EWD). Following our previous analysis of the total eclipses experimented by AS 296 during its 1988–1995 outburst (Siviero & Munari 2005), we have performed a similar analysis for the symbiotic nova AS 338 using accurate $UBVR_CI_c$ photometry collected during its 2005 eclipse.

The symbiotic system AS 338 (= V1413 Aql, α = 19 03 52, δ = +16 28 32, J2000) entered in 1978 a nova outburst which is still far from the end. The outburst light curve shown in Figure 1 covers the last 25 years and displays a complex pattern characterized by a long-scale (about 10 yr) as well as short and periodic variability (434 days), the latter being due to total eclipses of the WD by the M giant companion.

All the eclipses in the system are somewhat different because of the continuously changing temperature and radius of the outbursting white dwarf. The ANS (Asiago Novae and Symbiotic stars) collaboration carried out a tight $UBVR_cI_C$ photometric and spectroscopic monitoring of the 2005 eclipse of AS 338. Photometric data were obtained with the telescopes belonging to ARAR (Bastia, RA)

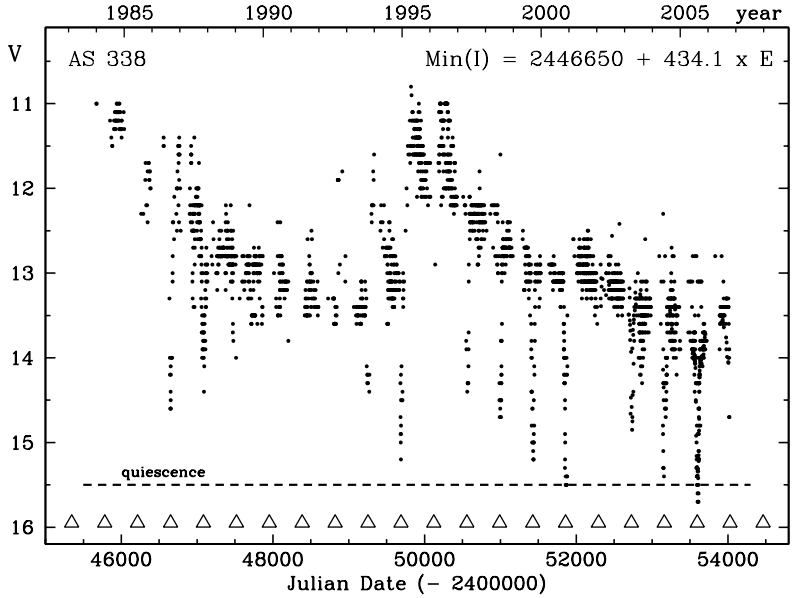

Fig. 1. Photometric evolution of the outburst of the eclipsing symbiotic star AS 338 from 1982 to 2006. Data are taken from AAVSO and VSOLJ databases. The dashed line denotes the magnitude at quiescent state and the triangles point to the eclipse dates. Ephemeris is from Munari (1992).

and to a private observatory in Como. Spectra are collected with the 1.82 m and 1.22 m telescopes operated in Asiago by the INAF Astronomical Observatory of Padova and the Department of Astronomy, University of Padova, respectively. We performed a preliminary analysis of the light curves of AS 338 using the `WD98K93d` version of the Wilson & Devinney code (Wilson & Devinney 1971; Milone et al. 1992). At the moment of this report, the light curve modeling (continuous line in Figure 3 left) is still preliminary, the final one needs to be linked to a set of accurate radial velocities (both for the M giant and the higher ionization emission lines tracing the orbital motion of the WD) that we plan to measure on the ∼80 high resolution Asiago Echelle + CCD spectra collected since 1988. The results of the preliminary modeling of the photometric data alone are presented in Table 1. They are in a good agreement with the Iben & Tutukov (1996) predictions.

Table 1. Radius, temperature and bolometric magnitude for the expanded white dwarf (EWD) and the late-type giant (LTG) as obtained from a preliminary solution using the WD98 code.

$R_{\rm EWD}$	=	81 $R_\odot$
$R_{\rm LTG}$	=	123 $R_\odot$
$T_{\rm EWD}$	=	9100 K
$T_{\rm LTG}$	=	3600 K
$M_{\rm bol,\,EWD}$	=	–6.75
$M_{\rm bol,\,LTG}$	=	–3.61
a	=	1.7 AU

We plan to carry out in the future a comprehensive photoionization modeling of the low resolution absolute spectrophotometry we obtained for AS 338 since 1987, and especially during the 2005 eclipse (Figure 2). The comparison of the WD radius and temperature from orbital solution and photoionization modeling will constrain the geometry of the emitting nebula and the sources of radiation within it.

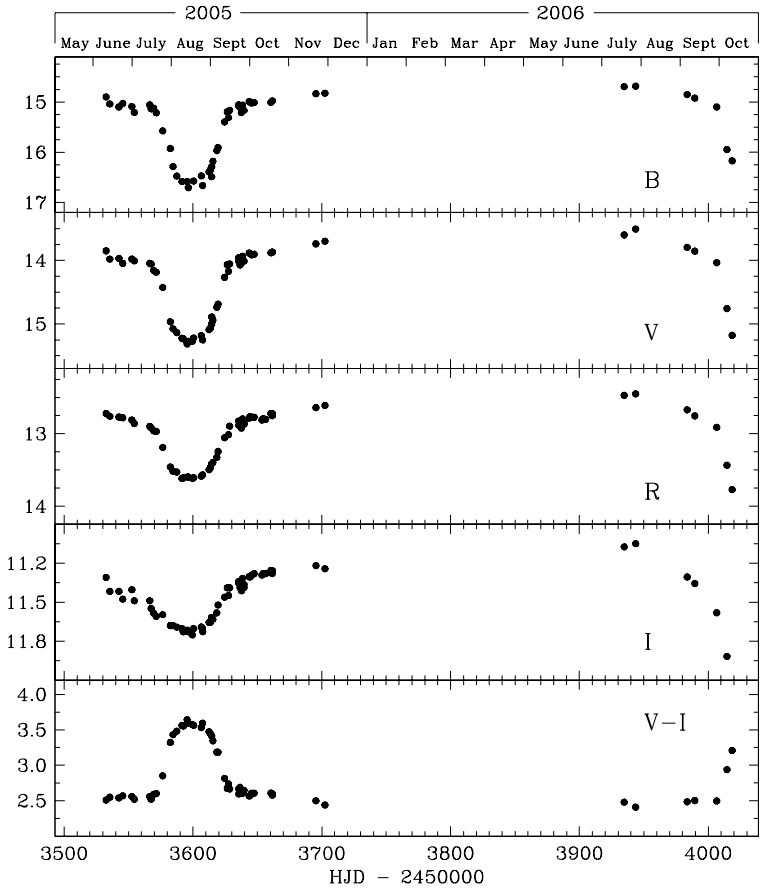

Fig. 2. Our light- and color-curves of AS 338 covering the 2005 and 2006 eclipses.

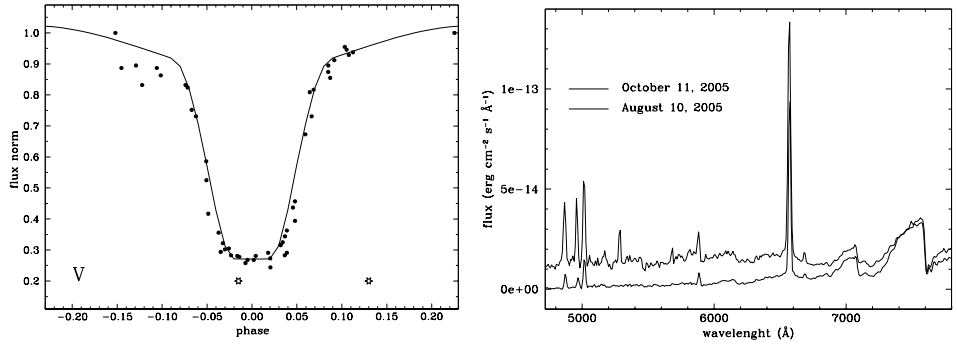

Fig. 3. Left-hand panel: the V light curve of the eclipse of 2005 with our orbital solution (Table 1) superimposed. Right-hand panel: the comparison of optical spectra during the total eclipse of 2005 and outside it (the phases of the spectra are shown in the left panel by two asterisks).

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