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HISTORICAL LIGHT CURVE AND THE 2016 OUTBURST OF THE SYMBIOTIC STAR StHα 169

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StHα 169 (J2000 α=19$^{\rm h}$49$^{\rm m}$57$\overset{\rm s}{.}$59, δ=+46°15′20$\overset{\prime\prime}{.}$6) was discovered by Stephenson (1986) during an objective prism search for emission line objects away from the Galactic plane. No information was logged on the type of spectrum or intensity of Hα emission, only its magnitude was recorded as $m_V > 13.5$. The symbiotic nature of StHα 169 was recognized by Downes & Keyes (1988) in the course of a spectroscopic survey of Stephenson (1986) objects. Their spectrum shows Balmer, HeI and HeII 4686 emission lines superimposed on the absorption spectrum of an M2 giant, similarly to what recently reported by Li et al. (2015) from a LAMOST survey spectrum. The classification by Downes & Keyes (1988) prompted the inclusion of the star in the catalog of symbiotic stars compiled by Belczyński et al. (2000). Henden & Munari (2008) reported $UBVRI$ photometry at three epochs in 2001, their mean values being V=13.68, $U-B$=+0.952, $B-V$=+1.64, $V-R_{\rm C}$=+1.04, and $V-I_{\rm C}$=+2.14. Pigulski et al. (2009) obtained V,$I_{\rm C}$ photometry of StHα 169 from June 2006 to Jan 2008, with mean values V=13.44 and $V-I_{\rm C}$=+2.03. Their short focal length did not resolve StHα 169 from a nearby field star, 10 arcsec to the East, for which Henden & Munari (2006) give V=16.606, $U-B$=+0.946, $B-V$=+1.208, $V-R_{\rm C}$=+0.745, and $V-I_{\rm C}$=+1.519. Correcting the Pigulski et al. (2009) photometry of StHα 169 for the contribution of this nearby field star provides V=13.50 and $V-I_{\rm C}$=+2.05, close to the 2001 values measured by Henden & Munari (2008). The star is situated within the field of view of the planet-hunter *Kepler* space mission. According to Ramsay et al. (2014) the *Kepler* unfiltered, white-light 2009-2013 data shows a quasi-periodic behaviour with a mean period of 34 days and an amplitude of a few per cent superimposed on a stable mean brightness, consistent with a low amplitude variability intrinsic to the cool giant. To a good approximation, this is all what is known about StHα 169, which can thus be appropriately labelled as one of the poorest studied symbiotic stars. We have been continuously monitoring StHα 169 since 2005, both photometrically and spectroscopically, and have recently reported on it entering an outburst state during 2016 (Munari & Graziani 2016).

$BVR_{\rm C}I_{\rm C}$ optical photometry of StHα 169 is regularly obtained with ANS Collaboration telescope N. 73, a 0.30-m f/10 Meade LX200 telescope located in Alfonsine (Ravenna, Italy). It is equipped with $UBVR_{\rm C}I_{\rm C}$ Astrodon filters. The CCD is a Finger Lake Instruments MAXCAM CM9-1E 512×512 array, 20 μm pixels ≡ 1.37″/pix, with a field of view of $11' \times 11'$. Image quality and plate scale allow full separation of the variable from the nearby field star above described, to the point that no difference is found between the results obtained with aperture photometry or PSF-fitting. The local photometric sequence, calibrated by Henden & Munari (2006) against Landolt equatorial standards, was used throughout the whole observing campaign, ensuing a high consistency of the data. Our BVR_CI_C photometry of StHα 169 is given in Table 1 (available electronic only), where the quoted uncertainties are the total error budget, which quadratically combines the measurement error on the variable with the error associated to the transformation from the local to the standard photometric system (as defined by the photometric comparison sequence). A detailed description of ANS Collaboration telescopes operation and data reduction is provided by Munari et al. (2012) and Munari & Moretti (2012).

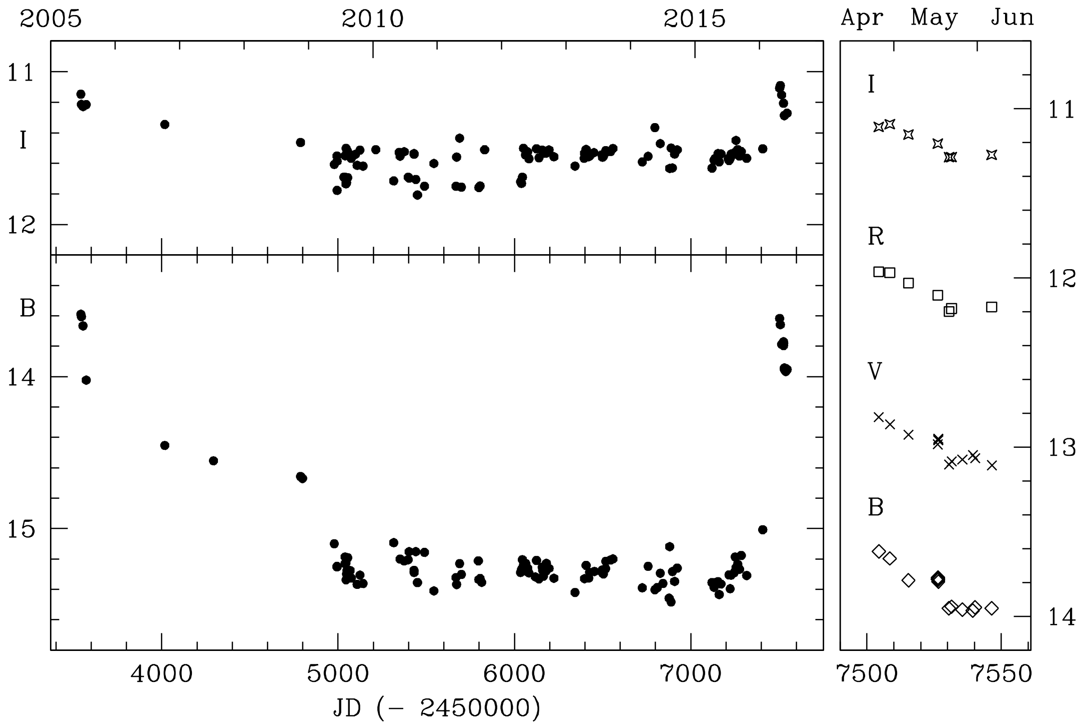

Figure 1. *Left:* overall 2005-2016 light curves in the B and I_C bands of StHα 169. *Right:* a zoom in all four BVR_CI_C bands on the 2016 outburst.

The 2005-2016 light curve of StHα 169 based on the data in Table 1 is presented in Figure 1. During 2005-2009 the variable appears declining from a large amplitude outburst (ΔB ~2 mag), which maximum could have occurred at an earlier date but later than mid-2001 when the photometric observations by Henden & Munari (2008) found it in quiescence. The amplitude of the outburst decreases with increasing wavelength (down to ΔI_C ~0.45 mag), as typical in symbiotic stars where the cool giant is usually a passive bystander of the eruption. From mid-2009 to Jan 2016, StHα 169 has remained at flat quiescence, and when the observations resumed in April 2016 we found the object declining from maximum during a new outburst. The start of the current outburst could be marked by the last observation of the previous observing season, on 2016 Jan 21, when StHα 169 appears already brighter than any other previous B-band quiescence observations (cf Figure 1). The recorded peak brightness for both the 2005 and 2016 outbursts is the same (B=13.6), as it is the same the initial fast decline. Only continued monitoring will reveal if the current outburst will replicate the behaviour of the previous eruption that was characterized by a much slower rate during the last magnitude of decline.

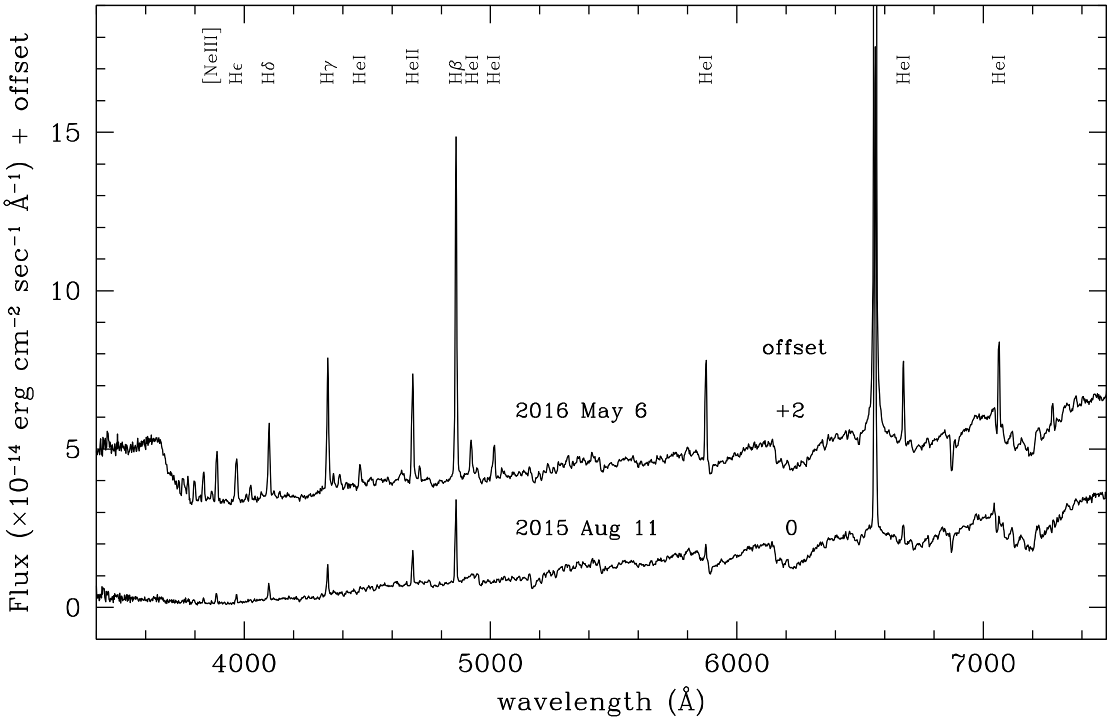

Figure 2. Fluxed low resolution spectra of StHα 169. The one for 2015 Aug 11 is typical of quiescence conditions, that for 2016 May 6 shows the appearance during the current outburst.

Low resolution spectra of StHα 169 are regularly obtained with the 1.22m telescope + B&C spectrograph operated in Asiago by the Department of Physics and Astronomy of the University of Padova. Figure 2 compares our last spectrum of StHα 169 during the preceding quiescence with one obtained during the current outburst. In outburst, a strong blue continuum overwhelms the M giant absorption spectrum short of 5800 Å, and the Balmer continuum turns into strong emission. The [NeV] 3426 and the OVI Raman scattering at 6825 Å, that are weakly present in quiescence, are gone. During outburst, the emission lines have largely increased their integrated flux, Balmer lines by 7×, HeII 4686 by 4.5× and HeI by 9×. The width of the emission lines remains sharp and the same as in quiescence, and no P-Cyg profile is visible.

To put our 2005-2016 CCD observations in a broader context, we have searched via the DASCH database the Harvard plate archive for historical data on StHα 169. We found the star to have been positively recorded on 94 blue sensitive Harvard plates. The corresponding light curve is plotted in Figure 3, where the original DASCH data have been shifted by +0.14 mag to match the modern B-band CCD scale. This shift has been derived by comparing the DASCH B-band magnitudes for the photometric comparison sequence around StHα 169 with the values published by Henden and Munari (2006). The shifted DASCH magnitudes are listed in Table 2 (available electronic only). The 1897-1951 light curve in Figure 3 is characterized by a series of brightenings superimposed on a general decline in brightness that affected StHα 169 until 1916, when the star settled on a quiescence characterized by the same mean B=15.29 value that we measured for

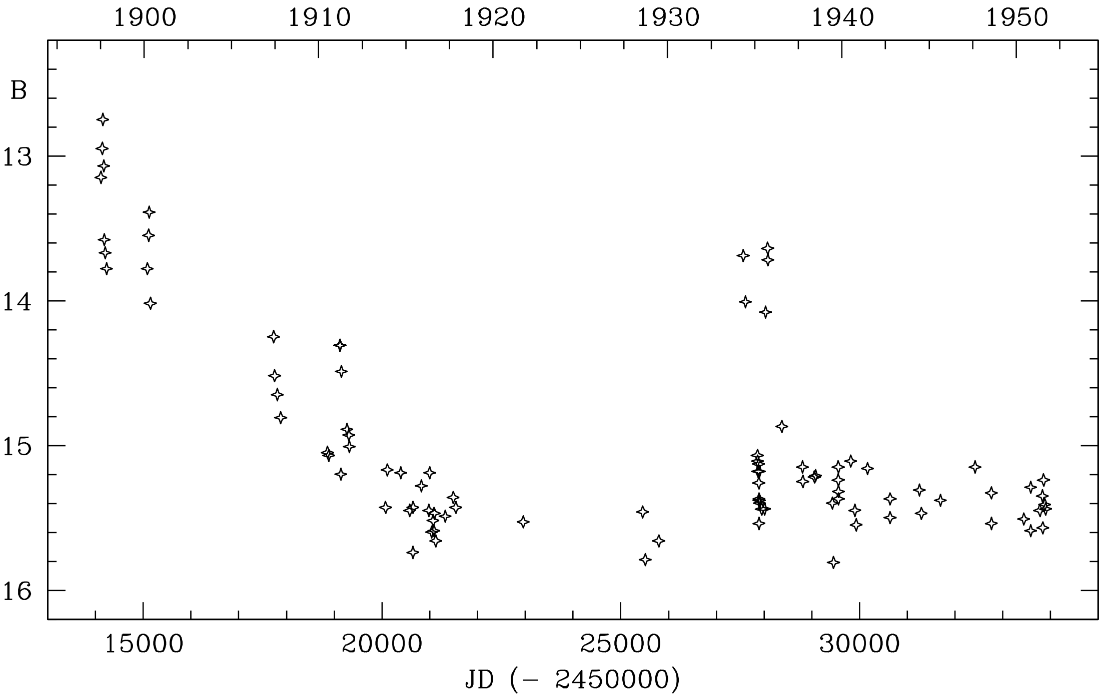

Figure 3. B-band historical light curve of StHα 169 from Harvard plates.

quiescence during 2009-2015. Two rapidly evolving outbursts were recorded in 1934 and 1935, both peaking at B ∼13.7 about 510 days apart. Such peak brightness is remarkably similar to the B=13.6 value characterizing both the 2005 and the 2016 events we have observed (cf Figure 1).

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