Baltic Astronomy, vol. 21, 177–179, 2012

RECONSTRUCTING HISTORICAL LIGHT CURVES OF SYMBIOTIC STARS AND NOVAE

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Received: 2011 September 1; accepted: 2011 September 15

Abstract. We reconstructed photometric histories of symbiotic stars and novae from direct inspection and measurement of photographic plates preserved at historical archives. We have completed the digging of the rich Asiago archive, and have started working on the Harvard plate stack, while other plate collections should be added soon. For homogeneity, we use the same $UBVR_{\rm C}I_{\rm C}$ photometric comparison sequences used in current CCD observations. This data harvest has permitted the discovery of past undetected outbursts and secular trends, or to derive previously unknown orbital periods and recurrence times, which are essential to constrain the nature of these capricious and variegated active binaries.

Key words: stars: binaries: symbiotic – stars: novae

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Symbiotic stars are binary objects that in general are quite active from a photometric point of view. They show variability from minutes (flickering) to several decades or centuries (outbursts of symbiotic novae). Orbital modulations have periodicities of a few years (or a few decades when the cool component is a Mira), and normal outburst phases develop over a time scale of a decade. There are several types of variability affecting symbiotic stars, those of larger amplitude being: (1) intrinsic (for example about 20 % of known symbiotics harbour a Mira pulsating variable); (2) ellipsoidal, when the cool giant fills its Roche lobe (presenting two maxima and two minima per orbital cycle); (3) outbursts, with amplitudes $\Delta B = 2-5$ mag and duration from half a year to a century or more. Their amplitude, duration and light curve shape are usually unpredictable, and consecutive outbursts may show marked photometric differences; (4) reflection effect, when the hard radiation field of the WD heats up the facing side of the cool giant, better visible at short wavelengths and characterized by a single minimum when the cool giant is at inferior conjunction; (5) eclipses by the cool giant of the white dwarf and/or inner/brighter nebular H II region; (6) re-processing by the circumstellar nebula of the energy radiated by the white dwarf mainly at wavelengths shorter than the atmospheric transmission cut-off; (7) episodes of obscuration by dust within the system, possibly related to orbital motion.

We reconstructed photometric histories of symbiotic stars and novae from

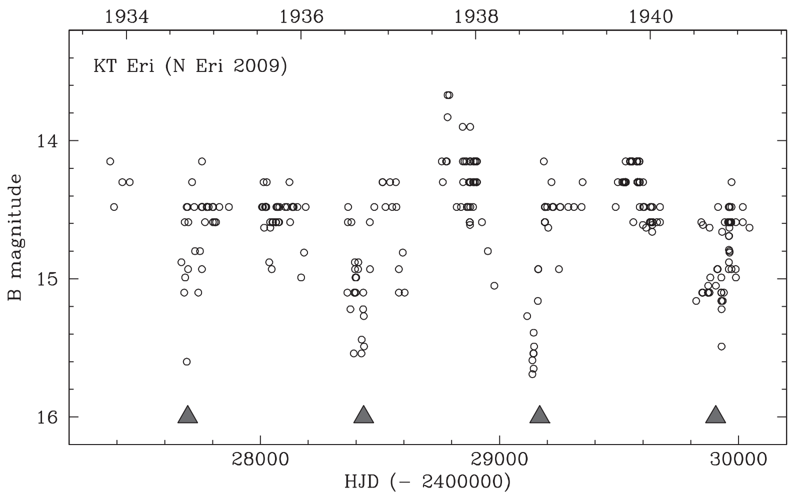

Fig. 1. A portion of the pre-outburst light curve for Nova Eri 2009 (KT Eri) that we reconstructed from Harvard plates obtained over the period 1888–1969 (from Jurdana-Šepić et al. 2012). The marked long periodicity suggests the donor star to be a giant and the system to have a high inclination angle. The possible presence in quiescence of high ionization emission lines of [Ne V] and [Ne III] (Nesci et al. 2009) qualify KT Eri as a new probable symbiotic star.

direct inspection and measurement of photographic plates preserved at historical archives. We have completed the digging of the rich Asiago archive (Munari et al. 2001; Munari & Jurdana-Šepić 2002; Jurdana-Šepić & Munari 2010), and have started working on the Harvard plate stack, while other plate collections should be added soon.

The recurrent time scale of novae is usually far longer than the time interval since the introduction in astronomy of photographic techniques. Nevertheless, new members of the exclusive club of recurrent novae may sometimes be discovered when plate archives are inspected following the eruption of a system (e.g., Nova Oph 1998, that Pagnotta et al. 2009 found to have been recorded in outburst on a Harvard plate on 1900 June 20). Sometimes the nova progenitor is bright enough during quiescence to be comfortably recorded on patrol plates. Search for orbitally related periodicities is of great interest because it can be used to infer the nature of the donor star, for example a low-mass main sequence object in a few hour orbit or a giant in a wide orbit of the order of months or years. As an example, Figure 1 shows a portion of the 1888–1969 light curve of the recent and enigmatic Nova Eri 2009 (KT Eri) reconstructed from the Harvard plates (Jurdana-Šepić et al. 2012). A marked periodicity close to 2 years is evident and support the idea that the donor star is a giant, not a main sequence star as in the vast majority of novae, or even a sub-giant like in U Sco type of recurrent novae. The large modulation of the orbit-related variability suggests a high inclination angle for the system.

Crucial to a successful inspection and measurement of the brightness of the stars on archive plates is the availability of good photometric sequences around them. Henden & Munari (2000, 2001, 2006) provided a highly homogeneous set of accurate and extended $UBVR_{\mathrm{C}}I_{\mathrm{C}}$ photometric comparison sequences of 81 symbiotic stars north of $\delta = -31°$, strictly linked to the Landolt's equatorial standards and intended to assist both present-time CCD photometry as well as measurement of photographic plates from historical archives. Extension to newly discovered or more southern symbiotic stars is in progress. Using these sequences and the color corrections, that is possible to calibrate on them, allows a direct comparison of historical data with present-day monitoring. For novae, the availability of a systematic series of comparison sequences is missing, which must be supplemented for by either sequences published in papers on individual novae or by new observations secured for this specific purpose.

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