RevMexAA (Serie de Conferencias), **20**, 187–189 (2004)

RECOVERY OF OLD NOVAE

L. Schmidtobreick,[1] C. Tappert,[2] R. E. Mennickent,[2] and A. Bianchini[3]

RESUMEN

Durante un proyecto a largo plazo dedicado a la investigación de novas clásicas con explosiones de grandes amplitudes hemos llevado a cabo fotometría a múltiples longitudes de onda y espectroscopía óptica de varios candidatos de novas viejas. Introducimos aquí el objetivo del proyecto, la búsqueda de novas con baja transferencia de masa y períodos orbitales cortos, y explicamos el método para recuperar estas novas viejas a través de sus características de color. Finalmente nos concentramos en los primeros resultados para una selección de objetos de nuestra muestra.

ABSTRACT

In the course of a long-term project investigating classical novae with large outburst amplitudes, we have performed multi–wavelength photometry and optical spectroscopy of several old–nova candidates. We here introduce the aim of the project, the search for low mass–transfer novae with short orbital periods, and explain the method to recover these old novae via their colour characteristics. Finally we concentrate on first results for selected objects in our sample.

Key Words: **NOVAE, CATACLYSMIC VARIABLES**

1. INTRODUCTION

Novae are a subclass of cataclysmic variable stars (CVs) and thus are interacting binary systems, which consist of a white dwarf primary accreting mass from a main sequence like late type secondary star. The evolutionary sequence of CVs is believed to go from high mass–transfer systems with long orbital periods above the period gap ($2.3 - 2.8\,\mathrm{h}$) towards the low mass–transfer systems with short orbital periods. The distribution of the various subclasses of CVs shows that at short orbital periods mainly dwarf novae are found, whereas novae usually show periods above three hours.

This might indicate that all novae are rather high mass–transfer systems, thus implying that they belong to the younger CV population and will eventually evolve into a low mass-transfer dwarf–nova. However it might also just be due to an observational bias, since low mass–transfer systems are intrinsically fainter and hence more likely to be overlooked or not further studied. Theoretical considerations allow for the possibility of low mass-transfer novae (Warner 1995, p.288) in the hibernation model, which assumes a cyclical evolution and thus predicts the coexistence of novae and dwarf novae at all evolutionary states.

To check for the presence of low mass-transfer novae with short orbital periods, we use a similar assumption that has been made for the 'tremendous outburst amplitude dwarf novae' (TOADs). Since the outburst mass-transfer rate is similar for all dwarf novae, and depends only weakly on the orbital period (Warner 1995, p.146), the (absolute) brightness differences among dwarf novae with different periods are much smaller in outburst than in quiescence (Warner 1995, p.117). Consequently, the outburst amplitude is very large for systems with very low mass-transfer rates in quiescence (Howell et al. 1995).

Although the outburst mechanism of novae is completely different, also the absolute magnitude of a nova explosion differs only slightly for different systems, as it depends mainly on the mass of the white dwarf (Livio 1992), the latter depending only weakly on the orbital period (Ritter & Kolb 1998). Therefore, similar to TOADs, an intrinsically faint pre– or post–nova is expected to show a large outburst amplitude.

The result of a first study of all novae with published period and magnitudes is plotted in Fig. 1. The graphic shows that so far only few novae are known with orbital periods below the period gap, but from the trend in the distribution, they are indeed expected to show rather large outburst magnitudes.

On the basis of the catalogue of Downes et al. (2001), we thus selected a total sample of 35 old novae in the southern hemisphere with possible out-

[1]European Southern Observatory, Chile.
[2]Grupo de Astronomía, Universidad de Concepción, Chile.
[3]Dipartimento di Astronomia, Università di Padova, Italy.

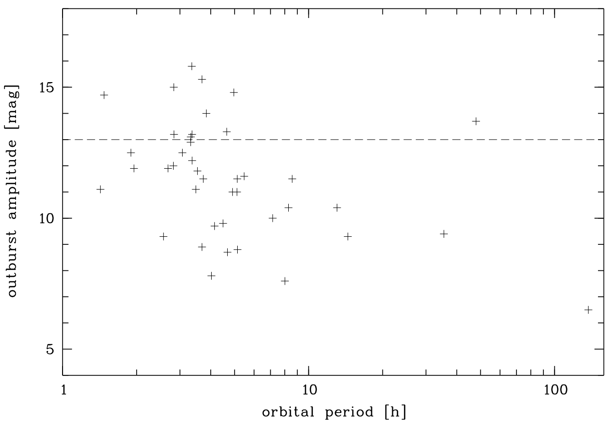

Fig. 1. Outburst amplitude vs. orbital period for all published novae. The dashed line indicates the lower outburst amplitude limit of our sample.

burst amplitudes > 13 mag. The exact value for most of these systems is not known, and several have still an uncertain identification of the old nova.

We plan to recover these old novae, to measure their quiescence magnitude thus deriving their outburst amplitude, and to determine their orbital period.

2. THE METHOD OF RECOVERY

The compound of the different physical CV components results in characteristic colour terms. CVs appear as generally very blue objects with a shift towards the red at longer wavelengths, depending on the strength of the secondary in comparison to the accretion disc or stream. In a colour–colour diagram, this quality places them on the blue side but slightly above the main sequence.

Performing multi–colour photometry on all stars within the field of a suspected old nova therefore gives the following picture: The majority of the stars are gathered along a main sequence. The latter is shifted from the theoretical one according to the mean interstellar reddening in the field, while the scatter of the stars indicates the variation of the extinction within the field. All candidates within the coordinate uncertainty of the nova will be marked. Assuming that the interstellar reddening of the nova is of the same order as the other field stars, it should be located on the blue side above the main sequence defined by the field stars, and can thus be identified.

To confirm the photometric classification, we then take a low–resolution spectrum of the suspected candidate.

3. SOME FIRST RESULTS

As an example a colour-colour-diagram of the stars in the field of V630 Sgr is plotted in Fig. 2.

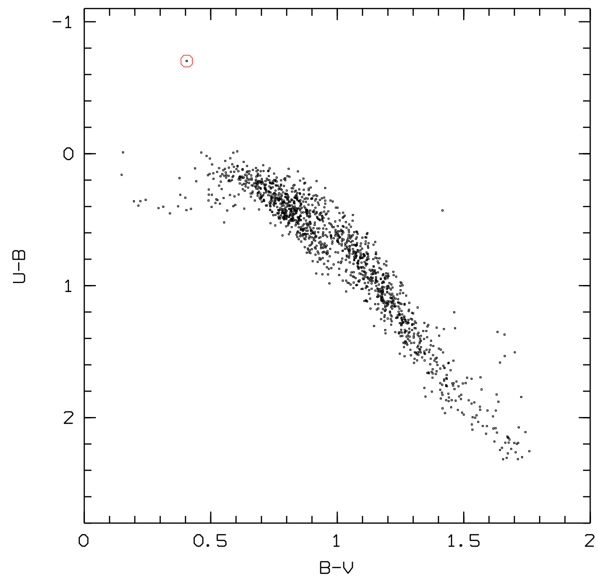

Fig. 2. The diagram shows U$-$B versus B$-$V for the stars in the field of V 630 Sgr. The nova itself is marked with a circle.

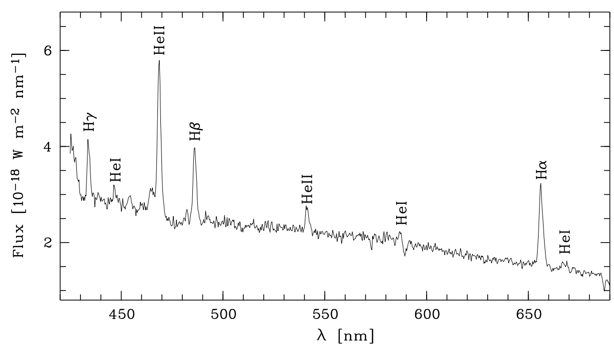

Fig. 3. Optical spectrum of V 630 Sgr, taken with DFOSC at the Danish 1.5m telescope at La Silla, Chile. The FWHM resolution is 1 nm.

One can clearly see the gathering of the field stars, thus defining the main sequence, shifted and spread due to individual interstellar reddening effects. The nova candidate distinctly stands out in this diagram. Fig. 3 shows the optical spectrum taken for this candidate to test the photometric recovery. The Balmer lines in emission, as well as the strong He II lines and the blue continuum confirm the correct identification of V630 Sgr.

An old nova of special interest is V840 Oph. The spectrum to confirm its identification showed a strong C IV emission at $\lambda = 580/1$ nm. Followup observations showed that the Bowen–blend is strong and carbon–dominated. The spectrum shows similarities to QU Car, a nova–like CV with an evolved carbon star as secondary (Drew et al. 2003). We

TABLE 1

THE OUTBURST AMPLITUDE

object	year	m_{max}	$V_{quies.}$	A
V693 CrA	1981	$v = 7.0$	21.0^m	14.0^m
V840 Oph	1917	$p = 6.5$	19.3^m	12.6^m
V630 Sgr	1936	$p = 4.5$	17.5^m	13.3^m

have concluded that similar to QU Car, the spectral features are best explained by assuming a carbon star secondary (Schmidtobreick et al. 2003a).

So far, six novae from our sample have been recovered, and spectroscopically confirmed. We have determined the outburst amplitude for three of them. To handle the photographic magnitudes, we have assumed a relation $p = V + 0.8(B - V)$. The resulting values are listed in Tab. 1. For V630 Sgr, also the orbital period is known; it has been determined by Woudt & Warner (2001) via high-speed photometry. The value $P_{\rm orb} = 2.83\,$h together with the outburst amplitude of 13.3^m fits nicely into the trend of the distribution shown in Fig. 1, and thus encourages the continuation of this project.

Two promising candidates for low mass-transfer novae with short orbital periods below the period gap are XX Tau and V842 Cen. Both show a spectrum with strong Balmer lines, strong He I instead of He II and thus resemble more a dwarf nova than a classical nova (Schmidtobreick et al. 2003b). Observation will show, if these two objects present indeed a link between the nova and dwarf nova populations.

We acknowledge the extensive use of the Simbad database operated at CDS, Strasbourg, France.

REFERENCES

Cohen, J.G. 1985, ApJ, 292, 90

Downes R.A., Webbink R.F., Shara M.M., Ritter H., Kolb U., Duerbeck H.W. 2001, PASP, 113, 764, living edition

Drew, J.E., Hartley, L.E., Long, K.S., & van der Walt, J. 2003, MNRAS, 338, 401

Howell, S.B., Szkody, P., Cannizzo, J.K. 1995, ApJ, 439, 337

Livio, M. 1992, ApJ, 393, 516

Ritter, H., Kolb, U., 1998, A&AS, 129, 83

Schmidtobreick, L., Tappert, C., Bianchini, A., & Mennickent, R.E. 2003a, A&A, in press

Schmidtobreick, L., Tappert, C., Bianchini, A., & Mennickent, R.E. 2003b, this conference, submitted

Warner, B. 1995, Cataclysmic Variable Stars, Cambridge University Press

Woudt, P.A. & Warner, B. 2001, MNRAS, 328, 159

Antonio Bianchini: Dipartimento di Astronomia, Università di Padova, Vicolo dell'Osservatorio 2, I-35122, Padova, Italy (bianchini@pd.astro.it)

Ronald Mennickent and Claus Tappert: Grupo de Astronomía, Universidad de Concepción, Casilla 160–C, Concepción, Chile (rm:rmennick@stars.cfm.udec.cl, ct: claus@gemini.cfm.udec.cl).

Linda Schmidtobreick: European Southern Observatory, Casilla 19001, Santiago 19, Chile (lschmidt@eso.org).