Binary Paths to Type Ia Supernovae Explosions
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The Post-Nova Population

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Abstract. We present our on-going project to unveil the post-nova population by re-discovering old novae that have been lost after the initial outburst and in which the binary itself is unobserved. We take UBVR photometry for candidate selection, long-slit spectroscopy to confirm these candidates, and time-resolved spectroscopy to measure the orbital period of the newly confirmed post-novae. Some preliminary results are shown as examples.

Keywords. stars: binaries, novae, cataclysmic variables

1. Introduction

Classical novae are a subgroup of cataclysmic variables that went through a thermonuclear runaway explosion on the white dwarf. These white dwarfs are considered possible candidates for Type Ia supernovae. Recurrent novae are especially known to exhibit massive white dwarfs close to the Chandrasekhar limit and at the same time have high accretion rates, both ingredients to make a future SN explosion likely. Classical novae with only one observed nova outburst are more frequent but their binary parameters, such as the white dwarf mass, are less well studied. To do this, one has to wait a few decades after the nova eruption until the characteristics of the underlying CV become dominant in the post-nova (see e.g. the detailed studies of RR Pic by Schmidtobreick *et al.* 2003a and 2008). Generally, the long-term behavior of pre- and postnovae is an open question (Vogt 1990; Duerbeck 1992) but important – for instance in context with the hibernation scenario (Shara *et al.* 1986). On the other hand, our actual knowledge of post-novae is largely incomplete: almost 3/4 of the 199 nova candidates that erupted before 1980 still lack spectroscopic observations or even an unambiguous identification of the post-nova.

A few years ago, we started a program to re-discover old novae, concentrating on the ones which exhibited large outburst amplitude. We recovered and confirmed several of these systems (see e.g. Schmidtobreick *et al.* 2003b, 2005). We now use a similar approach to find generally old novae that are not necessarily high outburst amplitude ones. We go one step further in the sense that we do not only want to recover the systems, but we also intend to derive the basic properties of the binaries which includes at the very least the determination of the orbital period of the recovered systems.

2. The Method

The observations are done in three steps:
(1) To select possible candidates for the old novae, we make use of the fact that the light from a cataclysmic variable is provided by at least three different physical components:

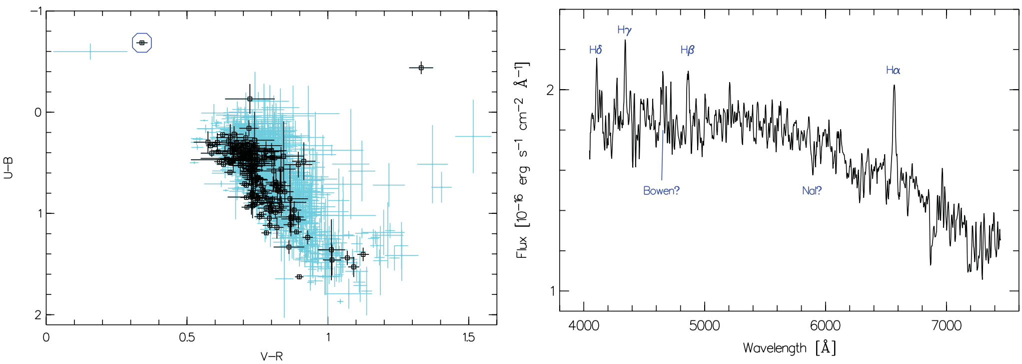

Figure 1. The left plot shows the color-color diagram of all stars in the field surrounding IL Nor – the stars in the inner 300×300 pixels are plotted as black squares. The best candidate for the old nova is marked with a circle. The right plot shows the spectrum of this best candidate. The typical emission lines confirm the classification as a cataclysmic variable.

the white dwarf, the secondary star, and the accretion disc or stream. Due to its size and high temperature, the latter is generally the dominant source in the optical range. While the white dwarf contribution affects mainly the UV range of the spectrum, the secondary late–type star contributes on the red and infrared side. The combination of these light sources results in characteristic color terms that are distinct from normal field stars. Cataclysmic variables appear as generally very blue objects with a shift towards the red at longer wavelengths. In a color–color diagram, they are thus found on the blue side but slightly above the main sequence. As an example, see the left diagram of Figure 1.
(2) To confirm the candidates of step (1), we take low resolution spectra and identify the cataclysmic variable via the typical emission lines (see right diagram of Figure 1).
(3) The last step is to take medium resolution time series spectroscopy of the confirmed old nova. We use the radial velocity variation of strong emission lines like Hα to determine at least the orbital period. In cases with good S/N and coverage, a further study of the line profile variation and a corresponding analysis of the accretion process is possible.

3. The Sample So Far

In total, we have observations for 21 novae so far, 17 of which have been confirmed spectroscopically. For the remaining four, several possible candidates were identified and await the spectroscopic confirmation. We have determined the orbital period for three systems and have constraints for two more. For more details on the results and a thorough analysis, we refer to Tappert *et al.* (2012). We conclude that our method works very well and the efficiency to recover the old novae is high. Further observations are planned to obtain a sufficiently large number of systems for population studies.

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