SUZAKU OBSERVATION OF THE CLASSICAL NOVA V2491 CYG IN QUIESCENCE.

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ABSTRACT

We present Suzaku XIS observation of V2491 Cyg (Nova Cyg 2008 No. 2) obtained in quiescence, more than two years after the outburst. The nova was detected as a very luminous source in a wide spectral range from soft to hard X-rays. A very soft blackbody-like component peaking at 0.5 keV indicates that either we observe remaining, localized hydrogen burning on the surface of the white dwarf, or accretion onto a magnetized polar cap. In the second case, V2491 Cyg is a candidate “soft intermediate polar”. We obtained the best fit for the X-ray spectra with several components: a hydrogen column $N(H)=2.5\times10^{17}$ cm$^{-2}$, a blackbody and a complex absorber. The later is typical of intermediate polars.

1. INTRODUCTION

Cataclysmic variables are close binary systems consisting of a white dwarf (WD) primary and a low-mass late type main sequence star transferring material via Roche-lobe overflow. If enough material is accumulated, the temperature and the pressure at the bottom of the accreted envelope can be high enough for a termolecular runaway and a classical nova (CN) explosion (see e.g. Starrfield et al. 2012 [Wolf et al. 2013]). When the ejected envelope becomes transparent to soft X-rays the system is observed as a super-soft X-ray source (SSS) revealing the hot WD atmosphere and nuclear burning (e.g. Orio et al. 2001; Krautter 2008; Orio 2012). V2491 Cyg was detected by Hiroshi Kaneda on 2008 April 10.728 at $V=7.7$ (Nakano et al. 2008). The nova was very fast: $t_2$ (time needed to decrease in luminosity by 2 mag) in the $V$ band was 4.6 days and the ejecta velocity reached 4860 km s$^{-1}$ (Tomov et al. 2008b). The nova had a short unusual “re-brightening” at the end of April, then reached the minimum brightness $V \sim 16$ after about 150 days. The interstellar reddening was $E(B-V) = 0.43$ (Rudy et al. 2008) corresponding to a hydrogen column $N(H)=2.5\times10^{21}$ cm$^{-2}$ (Bohlin et al. 1978).

Jurdana-Sepic & Munari (2008) discovered a persistent optical counterpart at $V=17.1$, which had a short dimming before the nova outburst. No previous outburst was known, but several authors suggested that an early transition of the optical spectrum to the He/N type (Tomov et al. 2008a), the velocity of the ejecta, and the rapid visual decay were all typical of the recurrent novae (RNe). However, this hypothesis has not been proven.

V2491 Cyg is strongly energy dependent and reaches maximum in the 0.8–2.0 keV range. We discuss the origin of the X-ray emission and pulsations, and the likelihood of the intermediate polar scenario.

Subject headings: cataclysmic variables: general — nova: individual (V2491 Cyg)
minosity remained constant for only two days and then faded slowly for 18 days, an unusual trend for post-nova SSS, most of which show an almost flat light curve after the peak and later fade rapidly. The WD in V2491 Cyg was among the hottest ever observed (Ness et al. [2011]), therefore it must be very massive (Starrfield et al. [2012]; Wolf et al. [2013]). Quite surprisingly, the WD did not seem to cool before the SSS final decay, while the minosity significantly decreased, as if the nuclear burning region was shrinking on the surface of the WD itself, at constant temperature (most nova SSS are observed to cool, see e.g. the review by Orio [2012]).

Baklanov et al. [2008] reported a variation with a period of 0.09580(5) days in the B and V bands between 10 and 20 days after the outburst. This variation may have been the orbital modulation of the binary system. However, Shugarov et al. [2010] did not detect the above period, although they monitored V2491 Cyg in optical for more than one year. Also Darnley et al. [2011] ruled out eclipsing orbital periods shorter than 0.15 days. Ness et al. [2011] reported 0.025 days (36 min) modulation in the B and V bands between 10 and 20 days after the outburst, however this variability was not observed in simultaneous UV observations and in the X-ray light curve obtained later, on day 49 after the nova explosion.

Several authors discussed the possibility of a magnetic scenario for V2491 Cyg (see Hachisu & Kato [2009]; Ibarra et al. [2009]; Takei et al. [2011]). Hachisu & Kato [2009] proposed that magnetic activity explains the rebrightening seen in the optical light curve, and that V2491 Cyg is a polar. However, Page et al. [2010] argued against this possibility. Using the synchronization condition they showed that if V2491 Cyg is a polar it should host one of most magnetic WDs known in binaries, assuming the WD mass about 1.3\,\text{M}_\odot and 0.0958 days orbital period. Although V2491 Cyg has a number of properties that are quite typical of magnetic WDs, such as strong Fe emission features at 6.4, 6.7, and 7.0\,keV, high X-ray luminosity in the range 2.0–10\,keV (Takei et al. [2011]), the existing data do not allow to finally prove or disprove the magnetic scenario.

The indications of large WD mass and high \(\dot{m}\) suggest that this nova is a rather “extreme” accreting WD, with characteristics we expect in a type Ia supernova (SN) progenitor and possibly with a strong magnetic field. We observed this intriguing CN with the Suzaku X-ray Imaging Spectrometer (XIS) in quiescence in order to monitor whether if the WD is still hot and to shed some light on its possible magnetic nature.

### 2. Observations and Data Analysis

V2491 Cyg was observed with the Suzaku XIS on 2010 November 3 with an exposure time of 74.4\,ks (for details see Table 1). The data were processed and analysed using HEASOFT v.6-13. We read the event files with XSELECT v2.4b and generated the detector and mirror responses using xisrfgen and xisrmfgen tools. We combined the XIS 0 and XIS 3 data from the front-illuminated (FI) CCD chips using addascaspec and the XIS 1 data from the back-illuminated (BI) CCD were analysed separately. The spectral analysis was performed with XSPEC v.12.8.0. The X-ray light curves were extracted after the barycentric correction and processed with XRONOS package.

### 3. Results

#### 3.1. Spectral Analysis

The background subtracted 0.3–10.0 keV spectra of V2491 Cyg are presented in Figure 1. The combined XIS 0 and the XIS 3 data are plotted in black, while the XIS 1 data are plotted in red. Solid lines show the best fit. The dashed lines represent the components of this model. The spectra seem to have a very soft component and a harder one with emission lines of highly ionized Fe, in particular the Fe XXV line at 6.7\,keV that indicates a thermal plasma. In order to fit the harder portion of the spectra we started with one thermal plasma component. However neither one, nor two components of collisionally-ionized diffuse gas (APEC model in XSPEC, calculated using the ATOMDB code v2.0.2) did not provide a statistically significant fit of the spectra with any temperature. The multi-temperature plasma emission model based on the MEKAL code (CEMEKL) also does not provide a good fit. We tried to add a reflection component, taking into account the presence of the very strong Fe Ka reflection line, but it resulted in unphysical values of the fitting parameters. The reflection scaling factor (R = \(\Omega/2\pi\), which is the covering fraction of the reflector viewed from the plasma, was close to 10. Such a value of R would imply that the source of the X-ray emission is hidden by a Compton-thick material and that we only see the reflected component, which is a rather unlikely possibility. Moreover, R = 10 implies that the EW of the Fe Ka reflection line should be \(\sim 1.5\,\text{keV}\) (George & Fabian [1991]), which is much larger than the EW inferred from the Gaussian fit of the line that we will show below.

The very flat slope in the 3.0–5.0 keV range points toward a complex absorption. The fit with the two-component thermal plasma model was much improved after multiplication with a partially covering absorber (PCFABS in XSPEC). We derived the following values of the column density and covering fraction of the partially covering absorber: N(H) = \(10^{22}\,\text{cm}^{-2}\) and CvrFract = 0.66. Page et al. [2010] also used a partially covering absorber with almost the same value of N(H) in their model to fit the spectra of V2491 Cyg obtained after day 80.

In order to fit the soft excess, seen in the XIS 1 data at 0.5\,keV, we added a blackbody component that was absorbed only by the simple absorption. We will further discuss why the blackbody component is not effected by the partially covering absorber. By adding to this four components a Gaussian to represent the Fe Kα line at 6.4\,keV, we finally obtained a statistically acceptable result with a value of \(\chi^2\) equal to 1.1. The abundance of the thermal plasma components is \(0.63_{-0.20}^{+0.37}\) with respect to solar. The value of N(H) derived from our fit...
TABLE 1
Observational log of the Suzaku observations of V2491 Cyg.

<table>
<thead>
<tr>
<th>Date and time</th>
<th>Instrument</th>
<th>Exposure (s)</th>
<th>Count rate (cts s(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-11-03 10:32:11</td>
<td>Suzaku XIS 0</td>
<td>74400</td>
<td>0.0494 ± 0.0010</td>
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<tr>
<td>2010-11-03 10:32:11</td>
<td>Suzaku XIS 1</td>
<td>74400</td>
<td>0.0684 ± 0.0012</td>
</tr>
<tr>
<td>2010-11-03 10:32:11</td>
<td>Suzaku XIS 3</td>
<td>74400</td>
<td>0.0550 ± 0.0010</td>
</tr>
</tbody>
</table>

**Notes.** Suzaku XIS FI are XIS 0 and XIS 3 detectors with front-illuminated (FI) CCDs, while Suzaku XIS BI is the XIS 1 that utilizes a back-illuminated (BI) CCD.
The parameters of the best fitting models — wabs×(bb/"atm"+pcfabs×(apec+apec+gauss)) for V2491 Cyg X-ray spectra, where "atm" is the WD atmosphere model.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>+Blackbody</th>
<th>+Atmosphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>N(H)[1]</td>
<td>0.25±0.06</td>
<td>0.19±0.07</td>
</tr>
<tr>
<td>N(H)pc[2]</td>
<td>13.3±2.4</td>
<td>10.8±2.9</td>
</tr>
<tr>
<td>CvrFract[3]</td>
<td>0.66±0.03</td>
<td>0.62±0.03</td>
</tr>
<tr>
<td>T_{bb/atm}(eV)</td>
<td>77.9</td>
<td>85.9±1.5</td>
</tr>
<tr>
<td>T_1 (keV)</td>
<td>0.24±0.03</td>
<td>0.29±0.05</td>
</tr>
<tr>
<td>T_2 (keV)</td>
<td>11.3±1.5</td>
<td>15.0±2.4</td>
</tr>
<tr>
<td>Norm_1[4]</td>
<td>5.7±1.1</td>
<td>6.9±2.8</td>
</tr>
<tr>
<td>Norm_2[4]</td>
<td>14.6±1.6</td>
<td>14.1±1.0</td>
</tr>
<tr>
<td>Flux_{abs}[5]</td>
<td>1.92±0.23</td>
<td>1.93±0.6</td>
</tr>
<tr>
<td>Flux_{unabs}[5]</td>
<td>6.66</td>
<td>3.95</td>
</tr>
<tr>
<td>Flux_{bb/atm}[6]</td>
<td>0.346</td>
<td>0.284</td>
</tr>
<tr>
<td>Flux_{bb}[6]</td>
<td>7.80</td>
<td>2.66</td>
</tr>
<tr>
<td>\chi^2</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>L_{2.0–10.0keV}[7]</td>
<td>1.82</td>
<td>1.82</td>
</tr>
<tr>
<td>L_{bb/atm}[8]</td>
<td>1.4±0.7</td>
<td>1.72±0.9</td>
</tr>
<tr>
<td>R_{bb/atm} cm[9]</td>
<td>1.2±0.4</td>
<td>1.4±0.5</td>
</tr>
</tbody>
</table>

Notes. The errors represent the 90% confidence region for a single parameter.

[1] ×10^{22} cm^{-2}, N(H) of the partial covering absorber.
[3] Normalization constants of the apec model (×10^{-4} cm^{-5}).
[4] The X-ray flux (×10^{-12} erg cm^{-2} s^{-1}) measured in the range 0.3–10.0 keV. Flux_{unabs} represents the value of the X-ray flux, corrected for the interstellar absorption only.
[5] The X-ray flux (×10^{-12} erg cm^{-2} s^{-1}) of the blackbody and WD atmosphere components measured in the range 0.2–10.0 keV.
[6] The bolometric X-ray luminosity (×10^{34} erg s^{-1}) we assumed D=10.5 kpc (Helton et al. 2008).
[7] The bolometric X-ray luminosity (×10^{35} erg s^{-1}) of the blackbody and atmospheric components. L_{bb/atm} were calculated based on the normalization constants of the models. The atmospheric model gives the value of the WD radius R_{WD} = 10^{-11} × \sqrt{\text{norm} × D}, which can be translated to the L_{atm} using the Stefan-Boltzmann law.
[8] The radius of the emitting region (×10^7 cm D_{10.5kpc}).

Fig. 2.— The Suzaku XIS spectra of V2491 Cyg in the 5.0–9.0 keV range showing the Fe K complex. The three Gaussians represent the Fe I, Fe XXV and Fe XXVI lines.

Fig. 3.— Periodogram of the Suzaku light curve of V2491 Cyg. We analysed the BI data in the 0.3–10.0 keV energy range binned every 80 seconds. The upper power spectrum was obtained with the PDM method and the bottom plot with the LS method. The highest peaks are marked with the arrows together with the corresponding values of the periods. The false alarm probability of 0.3% level is marked with the dashed line in the bottom plot.
TABLE 3

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Fe I</th>
<th>Fe XXV</th>
<th>Fe XXVI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy center (keV)</td>
<td>6.40 (frozen)</td>
<td>6.65^{+0.03}_{-0.03}</td>
<td>6.97 (frozen)</td>
</tr>
<tr>
<td>EW (eV)*</td>
<td>246^{+53}_{-50}</td>
<td>133^{+48}_{-44}</td>
<td>132^{+56}_{-45}</td>
</tr>
<tr>
<td>Flux_{unabs}**</td>
<td>7.20</td>
<td>4.95</td>
<td>3.49</td>
</tr>
</tbody>
</table>

Notes. $\chi^2$ is 0.98. All the parameters were derived at 90% confidence level.
* Equivalents width.
** The X-ray flux ($\times 10^{-14}$ erg cm$^{-2}$ s$^{-1}$).

In order to localize the pulsating component we subdivided the 0.3–3.0 keV energy range in three spectral intervals: 0.3–0.6 keV, 0.6–1.0 keV, 1.0–2.0 keV and 2.0–3.0 keV. The energy intervals were chosen based on the spectral fit. We expected the 0.3–0.6 keV range to be dominated by the blackbody, the 1.0–2.0 and 2.0–3.0 keV intervals to represent mostly the high temperature thermal plasma emission, and the 0.6–1.0 keV range to include emission from the blackbody and two thermal plasma components at the same time. The result can be seen in Figure 6. The periodic variation is observed between the 0.6–2.0 keV, but it is almost negligible in the harder ranges. The pulse profiles are roughly phase aligned. There is a slight shift between the maxima of the profiles that is within the errors. In the 0.3–0.6 keV energy range the variations have the same amplitude, but are irregular.

In order to asses the stability of this period we split the Suzaku light curve in two intervals and searched the period in each of them. In Fig. 7 the periodogram (left panels) and the phase folded light curves (right panels) of the first and the second parts of the dataset are plotted together. The light curves were folded with the same period of 0.0266 days in order to compare the pulse profiles. We found that the ~38 min period does not seem to be stable: the best-fit periods measured in the first and the second halves of the observation are different by 1.4%.

The energy dependence of the amplitude and the hardening at minimum suggest that absorption causes the observed 38.3 min modulation in the X-ray flux. The absence of clear modulation in the 0.3–0.6 keV range (where the blackbody emission dominates) indicates that the blackbody-like component is not affected by the partially covering absorber. This is the reason why we only applied the interstellar absorption to the blackbody component. Evans & Hellier (2007) discussed the geometry which allows to observe a blackbody-like component in a soft IP even when the accretion curtain crosses the line of sight.

4. DISCUSSION

4.1. The blackbody-like component

Using the fakeit tool in XSPEC, we found that the count rate obtained with Suzaku corresponds to a 0.039 cnts s$^{-1}$ Swift count rate, which is comparable with the last Swift observations presented in Page et al. (2010),
extracted in the 0.8–3.0 keV energy range and binned every 80 s. We analysed the light curve in each half are marked. Right panels: the first (top) and the second (bottom) halves of the Suzaku plot.

Fig. 6.— The Suzaku BI light curves of V2491 Cyg in different energy ranges folded with the period of 0.0266 days. The corresponding energy range is indicated in the bottom-left corner of each plot.

Almost 250 days after the outbursts, Page et al. (2010) obtained the best fit of the X-ray spectra of V2491 Cyg with an optically thin hard X-ray plasma and added a blackbody for the SSS phase. These authors also showed that the temperature of the blackbody initially increased and then stabilised around day 57 at the value $\sim 70$ eV. Further decrease of the X-ray flux in the soft X-ray range seemed to result of a shrinking of the emitting region. The emitting region continued to shrink even after it reached the size of the WD, instead of becoming cooler at a constant radius like in many other novae (see Rauch et al. 2010, for V4743 Sgr).

In our data we found that the blackbody-like component is still present and has a temperature $77^{+5}_{-7}$ eV. The normalization constant of the blackbody model gives a luminosity $1.4 \times 10^{35} D_{10.5kpc}^{2}$ erg s$^{-1}$ and an emitting radius $1.2 \times 10^{-7} D_{10.5kpc}^{-1}$ cm. A close emitting radius value was found in the fit with the stellar atmosphere model with a slightly higher temperature. Such a radius of the emitting region is too large for a polar cap on a magnetic WD, but is still more than an order of magnitude smaller than a WD radius. The fit with the WD atmosphere model is statistically indistinguishable from the one with a blackbody and does not allow to choose between the localized hydrogen burning and the polar cap as a possible source of the soft X-ray radiation.

The constant-temperature at decreasing radius, well below the WD radius dimensions, derived by Page et al. (2010) was not observed in other novae and contradicts the models. We are intrigued by the possibility that we still observe the same blackbody component after more than two years. Could it be due to residual nuclear burning, possibly continuing in this post-outburst quiescent phase in a smaller region than the whole WD? Orio & Shaviv (1993) predicted the possibility of localized thermonuclear burning on a WD. Other authors have argued that the burning would not remain localized and eventually the thermonuclear flash would propagate over the whole WD surface, (e.g. Gisler et al. 2012), very differently for instance from helium burning on a neutron star.

On the other hand, a distinct blackbody component with temperature in the range 20–100 eV, heavily absorbed by dense material partially covering the X-ray source, is observed in many IPs (Evans & Hellier 2007; Anzolin et al. 2008; Bernardini et al. 2012 and references therein). These objects form a growing group of so-called “soft IPs”, including fifteen confirmed IPs (Bernardini et al. 2012). Bernardini et al. (2012) in their nine objects sample found two new IPs with a blackbody component with $T_{bb} = 70$–80 eV. These authors showed that the WD spot area (the source of a blackbody radiation) is $4.5 \times 10^{14} D_{900pc}^{2}$ cm$^2$ in V2069 Cyg and $6.3 \times 10^{13} D_{1kpc}^{2}$ cm$^2$ in RX J0636. These values are still smaller than the size that we obtained for V2491 Cyg ($1.8 \times 10^{15} D_{10.5kpc}^{2}$ cm$^2$), but can be comparable taking into account uncertainties in the distance determination for both of them.

It should also be stressed that with the existing data, we cannot rule out that the supersoft flux has more than one origin, for instance that there are unresolved narrow emission lines merging with the soft continuum and making the source appear more luminous in the super-
soft range. In archival data of V2487 Oph and V4743 Sgr (Hernanz 2014, Zenko et al., in prep.) we found that the post-outburst RGS spectra, albeit with low signal-to-noise ratio, still show emission lines in the softest range. At this stage, this possibility is only speculative, but it should be taken into account as it may imply a lower supersoft X-ray luminosity that estimated in our broadband fit with Suzaku.

In calculating the luminosity we assumed the widely adopted distance d=10.5 kpc (Helton et al. 2008, Munari et al. 2011) independently found 14 kpc using the interstellar Na I line to evaluate the reddening. Although these distances have been inferred with the maximum-magnitude rate-of-decay (MMRD) relationship and these values may thus be highly uncertain (the relationship does not hold for RNe and sometimes is not very precise for CNe, moreover the nova had a rare secondary optical maximum), the optical and especially the supersoft X-ray luminosity in the outburst indicate that the distance cannot be much smaller. Especially the large supersoft X-ray flux (Page et al. 2010; Ness et al. 2011) is evidence of a distance of at least 10 kpc, otherwise the WD would have been underluminous compared with the models of the same high effective temperature (from 9 × 105 to a 106 K, see Starrfield et al. 2012, Wolf et al. 2013) and also with previous observations of novae in the SSS phase (see Orio 2012, for a review).

4.2. The 38 min period

In our Suzaku observations we detected the X-ray light curve modulation with a period of 38.3 min (0.0266 days). Shugarov et al. (2011) detected a 0.02885 days (41.54 min) modulation in optical data in the V band obtained between 2008 May 02 and 2009 November 23. We analysed the same dataset with the PDM method and found that the 0.02885 days period is most probably a daily alias of a 0.02655 days (38.23 min) period, which is very close to the one we found in X-rays. Our analysis of the energy dependence of pulses indicates that absorption causes the observed 38.3 min modulation and the timescale implies that the absorber is somewhere close to the WD. The detected 38.3 min modulation may be the WD rotational period. However, the peak that corresponds to this period in the LS periodogram is not as prominent as usually measured in IPs. There is a small, but puzzling difference in periods measured in the first and in the second halves of the Suzaku exposure. However, given the data quality, we cannot rule out that the modulation is strictly periodic. On the other hand, if the 38.3 min period is not related to the WD spin, it is not clear what else may play a role in the time-dependent and compact absorber causing this modulation.

4.3. Magnetic driven accretion in V2491 Cyg

Some indications of a magnetic nature of V2491 Cyg can be found in spectral characteristics, also discussed by Takei et al. (2011). These are our main findings:

- The hard X-ray band (2.0–10.0 keV) luminosity of V2491 Cyg is 1.82×1034 erg s⁻¹, which is higher than in most IPs (L_X is usually ≤ 1033 erg s⁻¹ Warner 2003, Pretorius & Mukai 2014). In IPs the moderately hard X-ray emission mostly originates in high energy plasma produced by the accretion shock on the surface of the WD.
- The observed blackbody-like component may place V2491 Cyg in the group of “soft IPs”. The blackbody temperature and the emitting area are comparable with these systems.
- If V2491 Cyg is a “soft IP”, the soft X-ray flux emitting region underwent a seamless, early transition from nuclear burning to accretion spot emission, taking into account the observations of Page et al. (2010).
- There are two optically thin plasma components with characteristic temperatures ~0.2 keV and ~10-20 keV, which may be due to a temperature gradient in the post-shock region.
- We need a complex, partially covering absorber with N(H)~ 1023 cm⁻² to fit the data, like in many IPs. This phenomenon is usually caused by the accretion curtains crossing the line of sight (Evans & Hellier 2007, Amzolin et al. 2008).
- The equivalent width of the Fe Kα line in V2491 Cyg is very large, 246 eV, like usually in IPs (see Norton et al. 1991, Ezuka & Ishida 1999, for the Fe lines in IPs). This is evidence of reflection of the X-ray emitting plasma, most probably from the surface of the WD (George & Fabian 1991). It may also indicate copious X-ray emission above the Suzaku XIS detectors’ range. However, the observed Compton thin absorber can also contribute to the 6.4 keV line (see Ezuka & Ishida 1999, Ezuka 2015).
- The most widely accepted proof of an IP, in which the WD is not synchronized with the orbital period, is the detection of the spin period in X-rays. The X-ray flux is modulated because the accretion channeled to the pole is shocked, so it is self-occluded and partially absorbed as the WD rotates. We detected an X-ray flux modulation with a period of ~38 min that can be attributed to the WD spin. Energy dependence of the amplitude of the pulses supports this assumption and is consistent with the accretion curtain scenario (Rosen et al. 1988, Hellier et al. 1991).
- However, this period is probably not entirely stable. On the other hand, detection of the spin period may not always be possible. Ramsay et al. (2008) suggested that if the magnetic and rotational axes of a WD are closely aligned, the spin rotation may be undetectable.

5. CONCLUSIONS

We presented the Suzaku XIS observation of the CN V2491 Cyg obtained in quiescence, more than two years after the outburst. The very high X-ray flux that we measured is close to the pre-outburst level (Ibarra et al. 2009) and to the values that were obtained about 250 days after the outburst (Page et al. 2010). It indicates a high X-ray luminosity, and hence high accretion rate. We found that the spectral characteristics of
the nova are very typical of “soft IP”, such as the presence of a blackbody-like component with $T_{bb} = 77$ eV, optically-thin thermal plasma emission with two characteristic temperatures and a partially-covering absorber. The hard band X-ray luminosity also indicates magnetic driven accretion. We detected the energy dependent X-ray flux modulation with period $\sim 38$ min that may be attributed to the WD rotation. However, there are uncertainties in the stability of the 38 min period, and in the origin of the blackbody-like component which may be due to residual and localized nuclear burning.

Magnetic WDs in novae have been observed in three systems: in two IPs (GK Per and DQ Her) and in one polar (V1500 Cyg). There are also several other IP candidates: V1425 Cyg, V533 Her and V842 Cen. There are also several other IP candidates: V1425 Cyg, V533 Her and V842 Cen.

If V2491 Cyg is NOT an IP, more questions remain unresolved. The first concerns the possible confinement of nuclear burning. A second question arises if accretion is channeled through the boundary layer of a disk; in this case the observed X-ray light curve modulation is most probably a quasi periodic oscillations, originating in the inner part of the accretion disk. However, this does not explain the energy dependence of the amplitude of the pulses.

An important measurement in further observations would be that of the orbital period. The Suzaku observations, presented in this paper, lasted for slightly shorter than two days and we did not find the orbital modulation, usually observed in X-rays in IPs [Parker et al. 2005].

To conclude, V2491 Cyg seems to be a puzzling key object to understand the secular evolution of novae. We suggest that it should still be observed in different wavelengths. A hard X-ray observation with NuSTAR would explain the origin of the strong 6.4 keV line. New soft X-ray observations would clarify the stability and nature of the $\sim 38.3$ min modulation of the X-ray flux. Finally, with optical observations we may measure the orbital period.

Facilities: Suzaku.

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