Identification of SRGt 062340.2-265751 as a bright, strongly variable, novalike cataclysmic variable


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ABSTRACT

We report the identification and follow-up of the transient SRGt 062340.2–265751 detected with both instruments on board the Spektrum-Roentgen-Gamma mission. Optical spectroscopy of the G = 12.5 counterpart firmly classifies the object as a novalike cataclysmic variable (CV) at a distance of 495 pc. A highly significant TESS period of 3.941 h, tentatively identified with the orbital period of the binary, could not be found when the object was reobserved with TESS two years later. The newer high-cadence TESS data revealed quasi-periodic oscillations around 25 min, while ground-based photometry indicated periodic variability at 32 min. Located in very sparsely populated regions of color-magnitude diagrams involving X-ray and optical magnitudes and colors, the new object could be an X-ray underluminous magnetic CV, an intermediate polar, or an overluminous nonmagnetic CV. The lack of uniquely identified spin and orbital periods prevents a final classification. The site of X-ray production in the system, \( L_{X, bol} = 4.8 \times 10^{32} \text{erg s}^{-1} \), remains to be understood given its high variability on long and short timescales.

Key words. novae, cataclysmic variables – X-rays: stars – stars: individual: SRGt062340.2-265751

1. Introduction

In the course of the second all-sky survey, on 2020 October 12, the two instruments on board the Spektrum-Roentgen-Gamma mission (SRG, Sunyaev et al. 2021) detected a bright transient at galactic coordinates \( l^{\text{II}} = 23^h7^m, b^{\text{II}} = -17^\circ6^\prime \). The comparison of data obtained during the first and second all-sky surveys with the two instruments on board the mission, the Mikhail Pavlinsky ART-XC (Pavlinsky et al. 2021) and eROSITA (Predehl et al. 2021), revealed an increase in X-ray flux of about a factor 2, but no further supporting information was available.

The X-ray and optical observations uniquely identify the transient with a nova-like cataclysmic variable (CV). CVs are close binaries with white dwarfs that accrete from a Roche-lobe filling star. In approximate terms, they may be physically divided into magnetic and nonmagnetic objects (disk accretion vs. quasi-radial accretion), and phenomenologically, they are often sorted into dwarf novae (DN, which are nonmagnetic disk-accreting CVs that may become unstable and cause the DN outburst) and so-called novalikes. Historically, both magnetic and nonmagnetic CVs were sorted into this last class. The nonmagnetic disk-accreting novalikes (often referred to as UX UMas, although the VY Scl, Z Cam, and SW Sex objects and possibly other subtypes may also fall in this class) are objects with high-accretion rates whose disks are permanently found in the hot state so that no dwarf nova outbursts are launched. CVs of all subtypes were expected to be found in large numbers through systematic spectroscopic follow-up of point-like sources serendipitously discovered in the ongoing all-sky surveys with eROSITA (Schwope 2012). The case considered here is unusual through its very high optical brightness and its high and strongly variable X-ray brightness in the hard SRG band as well, which allowed its discovery with both instruments on the spacecraft.

http://scan.sai.msu.ru/~denis/VarDOE.html
2. Observations and analysis

2.1. SRG

The transient of 2020 October 12 was observed at the eROSITA position $\alpha_{2000.0} = 6^h23^m39.7^s$, $\delta_{2000.0} = -26^\circ57'53''$ with a positional uncertainty of 15'' (0.6 statistical, 1''5 systematic). The Mikhail Pavlinsky ART-XC telescope detected the source at the position of $\alpha_{2000.0} = 6^h23^m39.7^s$, $\delta_{2000.0} = -26^\circ57'53''$ with an uncertainty of 15'' (90%).

During the second SRG survey, the object had a total exposure time of 85 s (an effective exposure time of 25 s) with ART-XC and was discovered at a mean flux of $1.3^{+0.4}_{-0.1} \times 10^{-11}$ erg cm$^{-2}$ s$^{-1}$ in the 4–12 keV energy band. It was below the detection threshold during the first survey, when it had an effective exposure time of 21 s, corresponding to an upper limit for the 4–12 keV flux of $F < 10^{-11}$ erg cm$^{-2}$ s$^{-1}$. With eROSITA, the source was detected in both surveys, in eRASS1 (2020 April 8), where it received a total exposure time of 228 s, with a mean count rate of $1.38 \pm 0.11$ s$^{-1}$, and in eRASS2 (2020 October 12) with a mean rate of $5.84 \pm 0.24$ s$^{-1}$ for a total exposure of 208 s.

More than 1200 photons were collected during eRASS2, which allowed generating the eRASS2 light curve that is displayed in Fig. 1. Circular regions with radii of 75'' and 100'' were used for the source and background extraction, respectively. SRGt 062340.2−265751 was observed during seven erodays$^2$ and showed variability between $10.7 \pm 0.7$ s$^{-1}$ and $1.3 \pm 0.2$ s$^{-1}$. Most of the photons registered with ART-XC were registered during the fourth and fifth eroday (see Fig. 1).

The combined spectrum from the two instruments on board SRG is displayed in Fig. 2. It was fit using XSPEC version 12.11 with a one-component emission model, a thermal plasma absorbed by cold interstellar matter. A scaling factor between the two spectral groups was also fit that accounts (a) for calibration uncertainties between the two involved instruments and (b) for the fact that the data were not taken strictly simultaneously, which is important given the high variability of the source. The C-statistic was used for fitting. The best-fit value found was 180 for 230 bins. This provides a temperature $kT = 5.7^{+2.6}_{-1.6}$ keV (errors given for a 90% confidence interval) and fluxes of $F_{\text{eRASS}} (0.5–2.0$ keV) $= 4.3^{+0.3}_{-0.4} \times 10^{-12}$ erg cm$^{-2}$ s$^{-1}$, $F_{\text{eRASS}} (0.5–10$ keV) $= 1.2^{+0.3}_{-0.4} \times 10^{-11}$ erg cm$^{-2}$ s$^{-1}$, and $F_{\text{ART}} (4–12$ keV) $= 2.0^{+0.4}_{-0.3} \times 10^{-11}$ erg cm$^{-2}$ s$^{-1}$. The column density was determined using the TBabs command (abundance set to wilms), but was not found to be well constrained. It was therefore fixed at the Galactic column density in this direction of $N_H = 4.08 \times 10^{20}$ cm$^{-2}$ (HI4PI Collaboration 2016). Recent 3D dust maps (e.g., Green et al. 2019) do not provide better constraints due to rather large errors, $E(g - r) = 0.03 \pm 0.02$. The implied column density is compatible with that inferred from X-rays. The same model applied to the eRASS1 data with a fixed amount of interstellar absorption gave a lower temperature $kT = 2.0^{+0.4}_{-0.2}$ keV at a flux of $F_X (0.5–2.0$ keV) $= (8.4 \pm 1.6) \times 10^{-13}$ erg cm$^{-2}$ s$^{-1}$. The bolometric flux of the best-fitting model during the high state in October 2020 was $F_X = 1.6 \times 10^{-11}$ erg cm$^{-2}$ s$^{-1}$ (eROSITA value).

2.2. Gaia

Gaia EDR3 lists an object (source ID 2899766827964264192) at a distance of 2′ from the eRASS2 catalog position of the transient at position RA = 95°91672681385, Dec = −26°96405593108. A finding circle indicating the eRASS2 X-ray position and all Gaia sources in its vicinity is reproduced in Fig. 3. It has a parallax of $\pi = 1.9749 \pm 0.0192$ mas and photometric properties $G = 12.436 \pm 0.005$ mag and $Bp – Rp = 0.023$. Following Bauer-Jones et al. (2021), the median geometric distance to SRGt 062340.2−265751 is 495.5 ± 4 pc, which gives an absolute magnitude $M(G) = 3.96$.

2.3. Archival X-ray observations

The position of SRGt 062340.2−265751 was covered previously by past (ROSAT) and current (XMM-Newton and Swift/XRT)
Table 1. Archival X-ray observations of SRGt 062340.2−265751 as derived from the ESA upper limit server HILIGT.

<table>
<thead>
<tr>
<th>Mission</th>
<th>Date</th>
<th>Exp. time (s)</th>
<th>Flux(^{(a)}) 0.2–2 keV</th>
<th>Flux(^{(a)}) 2–12 keV</th>
<th>Flux(^{(a)}) 0.2–12 keV</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROSAT-survey</td>
<td>1990-09-19 00:47:17</td>
<td>661.5</td>
<td>2.1 ± 0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>XMM-Newton slew</td>
<td>2003-04-01</td>
<td>5.6</td>
<td>2.3 ± 0.8</td>
<td>&lt;28.2</td>
<td>6.4 ± 2.0</td>
</tr>
<tr>
<td>XMM-Newton slew</td>
<td>2006-10-02</td>
<td>9.9</td>
<td>5.0 ± 0.8</td>
<td>11.6 ± 3.3</td>
<td>12.4 ± 1.8</td>
</tr>
<tr>
<td>Swift/XRT</td>
<td>2008-07-17</td>
<td>5558.3</td>
<td>1.7 ± 0.1</td>
<td>2.3 ± 0.2</td>
<td>3.8 ± 0.2</td>
</tr>
</tbody>
</table>

Notes. \(^{(a)}\) Absorbed flux in units of \(10^{-12}\) erg cm\(^{-2}\) s\(^{-1}\). Count rate to flux conversion performed with a power-law spectral model of slope 2 and absorption \(N_H = 3 \times 10^{20}\) cm\(^{-2}\).

Fig. 3. Finding chart of the new transient (3 × 3 arcmin). The background image is from the DSS, and the eROSITA position (eRASS2) is marked with a blue cross. All further Gaia objects in the field of view are marked with red crosses.

X-ray missions. The corresponding information is available via the ESA-supported high-energy light-curve generator HILIGT (upper limit server)\(^3\) and listed in Table 1. Although HILIGT does not offer a thermal spectral model to convert count rates into fluxes, the given values are at least indicative. The flux in the soft band, 0.2–2.0 keV, common to all the missions, was found to be variable by at least a factor 2.

2.4. Initial follow-up spectroscopy with WiFeS and SALT

The likely Gaia counterpart was selected for follow-up spectroscopy with the 2.3 m telescope of the Australian National University, which is equipped with the Wide Field Spectrograph (WiFeS; Dopita et al. 2010) and with the 10 m class Southern African Large Telescope (SALT; Buckley et al. 2006), which is equipped with the High Resolution Spectrograph (HRS; Crause et al. 2014). WiFeS is a double-beam, image-slicing, integral-field spectrograph. Observations were performed on 2020 October 28.164 with the R3000 grating and an exposure of 300 s. As the red arm of the instrument was not operating, only the blue wavelength range between 3500 and 5500 Å is available. The WiFeS spectrum was reduced using the PyWiFeS reduction pipeline (Childress et al. 2014), which produced three-dimensional data. We then extracted background-subtracted spectra from the slitlets that provided significant flux.

HRS is a dual-beam, fibre-fed échelle spectrograph, covering 3800–8900 Å. A 1200 s HRS observation was taken on 2020 October 31.9672 in low-resolution (LR; \(R \sim 15\ 000\)) mode. Initial reduction of the HRS spectrum was achieved using the PySALT package (Crawford et al. 2010), which includes overscan correction, bias subtraction, and gain correction. The spectrum was extracted using the HRS pipeline, based on MIDAS routines described in Kniazev et al. (2016). The ANU/WiFeS and SALT/HRS spectra are displayed in Fig. 4.
The object has a very blue continuum that increases to the short-wavelength cutoff at 3500 Å. The WiFeS spectrum reveals broad Balmer absorption lines whose centers are filled with intense emission lines. In addition to H-Balmer emission lines, the object displays He-emission lines, both neutral and ionized. Through these early spectra, the object is robustly identified as a CV. None of the spectra shows any sign of the donor star.

Through these early spectra, the object is robustly identified as a CV. All of the spectra show an intense emission lines. In addition to H-Balmer emission lines, the spectrum reveals a so-called cotrending basis vectors (CBVs, Smith et al. 2012), illustrating the feasibility of a radial velocity study.

2.5. TESS

We analyzed data from the Transiting Exoplanet Survey Satellite (TESS, Ricker et al. 2014). TESS, using four CCD cameras, obtains continuous optical images of a rectangular field of 24°×90° for 27.4 days at a short cadence (30 min to 20 s).

The main result of the analysis was obtained by dividing the background-corrected source flux by its median value of 513.1 electrons s⁻¹.

The typical full width at half maximum (FWHM) of the absorption lines corresponds to 3000 km s⁻¹, and those of the Balmer emission lines correspond to 300–380 km s⁻¹. The ionized helium line at 4686 Å is detected, but appears to be rather weak. It has an equivalent width of approximately −0.9 Å, a FWHM of ∼6 Å (∼380 km s⁻¹), and the flux ratio to the Balmer emission line Hβ is \( F(\text{He} II) / F(H\beta) \approx 0.26 \). Hβ has an equivalent width of ∼4.2 Å and a FWHM of ∼5.5 Å (∼340 km s⁻¹). The HRS spectrum of the region around He II 4686 also uncovers the Bowen blend of N III lines. This feature is often encountered in bright low-mass X-ray binaries (LMXBs, e.g., Cornellisse et al. 2008), but also in the two types of magnetic CVs, the polars and the intermediate polars (e.g., Schachter et al. 1991; Harlaftis & Horne 1999), indicating a strong UVEUV source.

The Hβ emission line has a centroid of 4861.54 Å in the SALT spectrum, whereas it was found at 4862.59 Å in the WiFeS spectrum while being similarly broad (5.2 Å vs. 5.5 Å). The difference in wavelength corresponds to a velocity difference of 65 km s⁻¹, illustrating the feasibility of a radial velocity study.

The source was observed in sector 6, which was observed at a 30-min cadence between MJD 58 467.79 to MJD 58 489.54 (2018 December 15 to 2019 January 06). The source was also observed in sector 33 at a faster 2-min cadence between MJD 59 201.24 (2020 December 18) and MJD 59 227.07 (2021 January 13).

We began the analysis with the data obtained in sector 6 (30 min cadence) and used the Python package Lightkurve (v1) (Lightkurve Collaboration 2018) to create the light-curves from the full-frame images (FFI). From the FFI from which we extracted our light curves, we selected pixels around the coordinates of the target, and background or empty pixels with no known Gaia sources as our background and with a median flux that is lower than a given threshold. We also used the TESS light curve from the MIT Quick-Look Pipeline (QLP, Huang et al. 2020) and compared them to our light curves from the full-frame images using the median background-removal method. The results from the two programs agreed well. The final extracted light curve (30 min cadence), normalized to the median value of 513.1 electrons s⁻¹, is displayed in Fig. 5. The light curve is flat to first order, but displays an apparent flickering that gives the impression of a possible periodic behavior. We thus performed a periodogram analysis to search for any underlying periodicity.

We performed period searches using the Lomb-Scargle (LS, Lomb 1976; Scargle 1982) and the phase dispersion minimization technique (PDM, Stellingwerf 1978) as implemented in the Astropy and the PyAstronomy packages (Astropy Collaboration 2018; Czesla et al. 2019). The LS-periodogram was then normalized by the residuals of the data around a constant reference model. The periodogram (Fig. 6) clearly shows an isolated peak around 3.941 h. The dotted line shows the periodogram level corresponding to a maximum peak false-alarm probability of 1% using the bootstrap method that simulates data at the same observation times to approximate the true distribution of peak maxima for the case without a periodic signal. The bootstrap method is performed with periods between 0.1 and 0.5 days and after normalizing by the residuals of the data around a constant reference model.

The main result of the analysis of the 30-min cadence data, the presence of a periodicity at about 3.9 h, was confirmed already in ATEL 14 222 by one of us (Pichardo-Marcano 2020). The more thorough analysis presented here confirms and refines the initial result. The light curve folded at the period of 3.941 h is shown in Fig. 7. It is slightly skewed, with a more gradual increase and a steeper decrease. There is significant scatter at any given phase, which indicates further variability on shorter timescales. This could not be resolved with the low-cadence TESS data of sector 6.

For the data obtained with a 2-min cadence we used the Pre-search Data Conditioning Simple Aperture Photometry flux (PDCSAP), in which long-term trends have been removed using so-called cotrending basis vectors (CBVs, Smith et al. 2012),
Fig. 7. TESS light curve for SRGt 062340.2−265751, folded on the 3.941-h period. Data are shown with their error bars. The solid lines represent the best-fit sinusoid. Phase zero was chosen arbitrarily.

Fig. 8. TESS light curve for SRGt 062340.2−265751 obtained in sector 33 with a 2 min cadence.

Fig. 9. Moving-window periodogram of the TESS 2-min cadence data for a sliding window of one-day length and time steps of two hours. The x-axis is the middle of the one-day window, and the color corresponds to the Lomb-Scargle power. The broken axis corresponds to the dates around the middle of the light curve that have some missing data.

produced by the TESS Science Processing Operations Center (SPOC; Jenkins et al. 2016). The light curve of data from sector 33 is shown in the original time sequence in Fig. 8. On this occasion, the source appeared fundamentally different compared to the data obtained in sector 6. At the beginning of the observations, the source was about 1.4 mag brighter than two years before, and at the end of this one-month interval only by about 0.9 mag. A Lomb-Scargle period search for the whole dataset from sector 33 no longer showed the 3.9 h modulation. We then selected shorter time intervals of one or two days length at the beginning, center, and end of the data train and searched for periodic behavior between 10 min and 5 h. This revealed some power at 25 min. To study the stability of this period, we calculated a dynamic periodogram using a time slice with a length of one day that was moved forward with a step size of 2 h. For each slice, an LS periodogram was computed, and the results were arranged as the two-dimensional periodogram (LS power as a function of time) that we show in Fig. 9.

Complementary views on the complex timing behavior of the source are given in Figs. 10 and 11, which show the false-alarm probabilities of the highest peak in each of the one-day periodograms and the mean periodogram of all the individual one-day periodograms. We found significant power centered around 25 min (frequency 57.6 d$^{-1}$), but measured significant frequencies that jumped between 45 and 65 cycles per day on timescales of about one day. No significant period was found during the last quarter of the data set. The mean periodogram has a maximum power at 24.37 min, and the most significant period in a one-day time slice is observed at 25.201 min with a false-alarm probability of 6.58 × 10$^{-16}$.

2.6. Archival photometry from CRTS, ZTF, ASAS-SN, and ATLAS

Archival photometric information of the new transient is available from the Catalina Real-Time Transient survey (CRTS, Drake et al. 2009, 196 epochs), the Zwicky Transient Facility (ZTF, Masci et al. 2019, 55 epochs), the All-Sky Automated Survey for Supernovae (ASAS-SN, Shappee et al. 2014; Kochanek et al. 2017, 3350 epochs), and the Asteroid Terrestrial-impact Last Alert System (ATLAS, Tonry et al. 2018; Heinze et al. 2018, 34 epochs). The observations of these surveys cover the time intervals 2005 August 28–2010 April 19, 2018 November 1 to 2019 November 18, 2014 February 11–2020 November 24, and 2021 February 16–2021 March 16, respectively, and part of them are shown in Fig. 12 (omitting the CRTS and ATLAS data).
ASASS-SN and ZTF photometric data for SRGt 062340.2−265751 (green symbols show ASAS-SN V, gray symbols show ASAS-SN g, and blue symbols represent ZTF g). The magenta triangles mark TESS observations with low and high cadence (the first and second pair identify TESS sectors 6 and 33, respectively).

ZTF data were taken in the g and r filters with only g-band data shown, and ASAS-SN data through g and V filters. All these data show extended phases (years) with little variability around a mean magnitude of about 12.5, with superposed scatter with an amplitude of 0.1 mag followed by dimmed phases with a larger short-term variability amplitude. These excursions toward lower brightness were observed twice, one at the end of the CRTS data train at MJD 56 350, and the other was covered by both ZTF (partially) and ASAS-SN at MJD 58 400. The minimum brightness of these fainter states is at around 13 mag. TESS observations in sector 6 revealing the 3.9h periodicity were obtained at the pronounced minimum. No automated survey data (e.g., ASAS-SN or ATLAS) are available at the time of writing when TESS observed the source again in sector 33.

We searched for periodic behavior of the source in the ASAS-SN data. We selected g-band data obtained between HJD 2 458 455 and 2 458 866. During this 400-day interval with 1072 data points, the transient recovered from its faint state at \( g = 12.95 \) to a bright state at \( g = 12.3 \) with a constant gradient. The brightness displayed a scatter with a mean amplitude of 0.085 mag around the trend, while the mean magnitude error was only 0.01 mag. We used the LS period search method as implemented in ESO-MIDAS and found a period \( 3.9142 \pm 0.0011 \) h, which is consistent with the value found in the TESS data at 2.5σ.

### 2.7. SAAO high-speed photometry

Following its spectral identification (see Sect. 2.4), we performed 3.2 h of high-speed photometry with the South African Astronomical Observatory 1.0 m telescope on 2020 November 1, beginning at 23:57:30 UTC. The Sutherland High speed Optical Camera (SHOC; Coppejans et al. 2013) CCD camera, which uses an Andor iXon888 frame transfer EM-CCD frame camera (1024×1024 pixels), was used. We used the LS period search method as implemented in ESO-MIDAS and found a period \( 3.9142 \pm 0.0011 \) h, which is consistent with the value found in the TESS data at 2.5σ.

### 3. Results and discussion

We have analyzed space- and ground-based data of SRGt 062340.2−265751, an object that was initially detected as an X-ray transient with the two X-ray instruments on board SRG. Follow-up data, in particular the initial spectroscopy, uniquely identify the object as a CV and thus confirm Denisenko’s previous classification. At \( G = 12.5 \) mag the object is clearly one that displays strong flickering that is typical of CVs and is reminiscent of some intermediate polars that exhibit spin-related periodic modulations. We therefore subjected the light curve to a Lomb-Scargle period analysis, probing frequencies as high as the Nyquist limit (0.6 s). Except for a strong peak at 0.480 mHz, there were no other significant peaks. The result is shown in Fig. 14. The strong peak corresponds to a period of 2080 ± 100 s (34.7 min).

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of the brighter examples of its class. An important question is to which, if any, CV family the object belongs.

The obtained spectra and the location of the object in the color-magnitude diagram (see Fig. 15) all strongly suggest that it belongs to the novalike subclass. No dwarf nova outburst was recorded in the multi-year monitoring observations by CRTS.

The great majority of novalikes are found above the CV period gap. It is thus tempting to associate the 3.9-h periodicity found in ASAS-SN and TESS data (sector 6) with the orbital period of the binary. The disappearance of this period in TESS sector 33 data is puzzling. It might be premature to associate the 3.9-h periodicity with the orbital period, and alternatively, the photometric phenomenology might be completely changed in the much higher accretion state of TESS sector 33 data. Time-resolved spectroscopy is needed to uniquely identify the orbital period by tracing the absorption lines and the emission cores through an orbital cycle. The blue optical continuum and the absorption lines are thought to originate from an optically thick accretion disk. The narrow emission lines might be resolved into two components, one to be associated with the cooler outer parts of the disk and the other originating from the irradiated hemisphere of the donor star (see, e.g., Beuermann & Thomas 1990; Hernandez et al. 2017, for templates), each with its own radial velocity curve.

The production sites of X-rays in nonmagnetic novalikes are debated. Originally, X-rays were assumed to originate from the boundary layer (BL) between the disk and the white dwarf with a blackbody-like spectral shape, but the predicted blackbodies were not found (Mauche & Mukai 2002). The BL is nevertheless mostly regarded as the X-ray production site. Other locations such as shocked circumstellar material, the polar caps, a central corona, a partially obscured boundary layer, or advective hot flows are discussed (Zemko et al. 2014; Dobrotka et al. 2017; Balman 2020). The already observed high degree of X-ray variability on long and short timescales, that is, between eRASS surveys and between erodays, together with dedicated spectral observations may shed new light on this old question. If it belongs to the nonmagnetic novalikes, SRGt 062340.2−265751 likely does not belong to the VY Scl subclass because it does not show the typical anti-dwarf nova dimmings by ~4 mag.

Accretion in the intermediate polars may occur through streams and disks. The disks may also be large and extend up to the Roche lobe of the accreting white dwarf (Hellier et al. 1991). The freely spinning white dwarf in an IP typically leads to very rich power spectra, in particular at X-ray wavelengths, in which orbital, spin, and different types of beat periods can be traced (dependent on the orbital inclination and the accretion mode, respectively, see, e.g., Norton et al. 1996). The high degree of X-ray variability through self-eclipses and foreshortening of the accretion spots and internal absorption by accretion curtains is common to all IPs. The observed large X-ray variability within eRASS2 and between the two SRG surveys may thus argue for an IP classification. Moreover, the SAAO-discovered period of 35 min and the TESS-discovered period at 25 min might support this view because if these periods are associated with the spin of the white dwarf, they are typical of IPs. In particular, the TESS-discovered periods at 25 min indicate an IP nature because many IPs are observed to cluster around period ratios of $P_{\text{spin}}/P_{\text{orb}} = 0.1$ (Norton et al. 2004, their Fig. 1), as implied for SRGt 062340.2−265751. To firmly classify the object as an IP, however, the detection of a stable spin period is required, which is lacking. The appearance and disappearance of periods at around half an hour is perhaps difficult to explain in either classification.

Optical power spectra of IPs are, however, affected by reprocessed radiation. Better insight is possible from a decent uninterrupted X-ray observation to uncover the intrinsic variability of the source on short timescales. The existing X-ray observations of SRGt 062340.2−265751 with SRG are insufficient to detect a ~2000 s period. This will require an extensive future observation (e.g., with XMM-Newton).

The X-ray spectrum of SRGt 062340.2−265751 is not too strongly absorbed and can be modeled with a single purely thermal emission component. No separate soft X-ray component was found, although the appearance of the Bowen blend appears to imply the existence of such a component. The
eRASS2 bolometric X-ray flux implies an accretion luminosity of \( L_{\text{X,bol}} = 4.8 \times 10^{36} \text{ erg s}^{-1} \), which is at the low end for an IP and at the high end for an UX UMa system.

In addition to the color-magnitude diagram of Fig. 15, it is instructive to locate SRGt 062340.2−265751 in an X-ray to optical color-color diagram based on eROSITA and Gaia, which is shown in Fig. 16. The diagrams were constructed in the following manner. The collaboration-internal preliminary eRASS2 catalog was matched to within the 8 arcsec FHWM of the point spread functions of the telescope modules of eROSITA with Gaia DR2. For the matching objects, distances were determined following Bailier-Jones et al. (2021). We then used the final edition of the Ritter & Kolb catalog (Ritter & Kolb 2003) to locate the CVs. The optically bright novalike CVs of the UX UMa type are identified with a different color in the diagrams. We also used the compilation of Koji Mukai4 to highlight the IPs that were identified in eRASS. The color \( B - R \) was taken directly from Gaia data. The X-ray to optical color was computed as log\((F_X(0.6−2.3\text{keV}) + \text{phot } g \_\text{mean} \_\text{mag}/2.5 + 4.86, and the chosen energy band was the standard band 2 in the current version of the catalog pipeline (pipeline version 946 Brunner et al. 2022).

Our Fig. 15 is to be compared with Fig. 2 of Abril et al. (2020), which locates the CV sub-families in the Gaia-DR2 HRD. Whether the floor of objects in Fig. 15 at \( G = 13 \) mag indicates real associations or is due to random associations needs to be determined. Most CVs are located between the white dwarf sequence and the main sequence. Their X-ray luminosities are orders of magnitude higher than those of coronally active stars on the main sequence. The novalike CVs, in particular the magnetic IPs, overlap in the color-magnitude diagram with coronally active stars, but they can be discerned through their much higher X-ray luminosity.

The color-color diagram of Fig. 16 has two main structures. The L-shaped sequence beginning at \((0.6,−5.5)\) with the knee at \((1,−3)\) delineates active stars, whereas the cloud around \((1,−0.5)\) is the domain of the active galactic nuclei. Most of the CVs cannot be distinguished from the numerous active galactic nuclei in this diagnostic diagram as long as no astrometric information can be used for a further distinction of galactic and extragalactic objects (see also Comparat et al. 2020, their Fig. 11).

The transient CV SRGt 062340.2−265751 is located in very sparsely populated areas in both diagrams. It optically belongs to the most luminous known X-ray detected CVs. It is bluer than most nonmagnetic UX UMa novalike CVs and bluer than all IPs, although it is not too much separated from the extreme representatives of these two classes. On the other hand, its X-ray to optical color is between that of the UX UMas and the IPs. For an IP, SRGt 062340.2−265751 is X-ray underluminous by about 1 dex; for a nonmagnetic novalike, it is also overluminous by about 1 dex.

At a Gaia magnitude of 12.5 mag, \( \text{SRGt}062340.2−265751 \), if identified as an IP, would be the IP with the brightest apparent magnitude in eRASS2 by far. The next brightest IP is TV Col at \( \text{phot } g \_\text{mean} \_\text{mag} = 13.9 \text{ mag} \). For comparison, the first soft X-ray discovered IP in the ROSAT all-sky survey, PQ Gem, was at \( \text{phot } g \_\text{mean} \_\text{mag} = 14.1 \text{ mag} \).

Although only a few objects are found in the vicinity of SRGt 062340.2−265751 in the diagnostic diagrams of Figs. 15 and 16, several candidates are located around our new discovery that will be identified in the next years with the large-scale identification programs of serendipitous eROSITA sources with the SDSS (Kollmeier et al. 2017), for instance. The journey has just begun.

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