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UBV Photometry of X-Ray System with M2 III Type Red Giant V934 Her (4U 1700+24)

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Abstract—V934 Her is a detached system, consisting of a cool giant and a neutron star. The neutron star accretes matter from the stellar wind of the giant. Multicolor photoelectric observations made in 1997—2011 revealed a 415-day period, close to that, discovered spectroscopically from radial velocities. This period is considered to be the orbital period of orbital motion of the neutron star around the red giant. The wave with this period in the U-band has the largest amplitude $0^{\rm m}_{.}12$. We also detected multiperiodic pulsations of the red giant. The light curve in the V-band is dominated by a pulsation wave with the period of 28.82 days and the amplitude of $0^{\rm m}_{.}10$.

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1. INTRODUCTION

The X-ray source 4U 1700+24 was first detected by the *Uhuru* [1] and *Ariel V* [2] satellites. The X-ray spectrum of the source reveals significant and complex long-term variations. The spectral properties of the source are best described by Comptonization with an excess in the region of less than 1 keV, where this excess is well-represented by the black body model with $kT_{\rm BB} \sim 1$ keV. The radiation excess disappears and cannot not be registered on the level of weak fluxes [3]. According to the data of the *RXTE/ASM* satellite, the source exhibited two X-ray outbursts. The first one occurred between 1997—1998, lasted 100 days and reached its maximum around JD 2450780. The second outburst occurred in 2002, lasted 250 days and its maximum was observed around JD 2452480. The X-ray spectrum becomes harder with increasing luminosity. During the first outburst, a hard X-ray tail emerged in the spectrum, spanning up to 100 keV [3]. With the new distance value of 420 pc [3] the luminosity of the source in the range of 2—10 keV varies within $2\times10^{32} - 1\times10^{34}$ erg/s. A neutron star, accreting matter from the stellar wind of a nearby normal star may possess such luminosity. As a result of X-ray tracking, some studies have even reported quasiperiodic flux variations with periods around 900 s (in [4] using the *IPC* instrument of the *Einstein* Space Observatory (HEAO-2) and in [5] with the *ROSAT* satellite X-ray telescope). Masetti et al. [3], however, monitoring the object in four observatories, have solely registered chaotic noise on the scales of dozens to thousands of seconds.

The optical counterpart of the X-ray source 4U 1700+24 was identified by Garcia et al. [4] with the positional accuracy of the *Einstein* Observatory *IPC* instrument. It turned out to be a red giant HD 154791 ($17^h\,06^m\,34^s_{.}52$ $+23^\circ58'18''.6$; 2000), which, despite the hard X-ray irradiation, has an "absolutely normal" optical spectrum. Later, Morgan and Garcia [5] confirmed this identification with a high resolution *HRI* camera of the *ROSAT* satellite X-ray telescope. The spectrum of the star was classified as M2 III type [6]. This spectrum did not reveal any emission lines, characteristic of X-ray systems with accretion (Hα, Hβ, He II 4686 Å) [4]. However, the ultraviolet spectrum, obtained with the *IUE* satellite, has manifested the emission lines of C IV 1550 Å N V 1238 Å and Mg II 2800 Å, which are usually not detected in the M-giants [4, 7]. Moreover, these lines displayed a considerable variability. The disappearance of emission components in the absorption line of Ca II 3933 Å was also noted.

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No significant variability was registered in the B and V-bands, but the U-filter from time to time recorded variability on the scale of a week with a small amplitude of up to $0\overset{m}{.}15$ [8]. As reported in [9], even during the large X-ray outburst of 1997, when the radiation flux in the range of $2-10$ keV has reached its maximum of 35 mCrab, the high-resolution spectrum in a broad range from Hδ to Hα did not reveal anything weird, and no emission lines have appeared. Nevertheless, the photometric observations of the *Hipparcos* satellite have demonstrated a variability within $7\overset{m}{.}62-7\overset{m}{.}78$ in the instrumental system with a possible period of $31\overset{d}{.}41$. The decision to designate V934 Her as a variable type-SRb star in the General Catalogue of Variable Stars (GCVS) was based on that.

In order to confirm the identity of the X-ray source 4U 1700+24 and the M-giant V934 Her, Galloway et al. [6] made a thorough spectroscopic study of the star in the optics, based on the 1982–1996 data, and analyzed a series of $RXTE/ASM$ X-ray monitoring data from 1996–2002. Radial velocities of the M-giant revealed a period of 404 ± 3 days. On the average, the half-amplitude of the radial velocity curve was equal to $K = 0.75 \pm 0.12$ km/s at the mean systemic velocity of -48.7 ± 0.1 km/s. The motion could be orbital, then the orbit eccentricity would amount to 0.26 ± 0.15, the semimajor axis projection $a \times \sin i = (4.2 \pm 0.7) \times 10^6$ km, and the longitude of periastron would be $\omega = 260° \pm 40°$. Is not improbable that the motion refers to the pulsations of the M-giant. The $RXTE/ASM$ revealed the modulation period of 404 ± 13 days with a sinusoidal flux curve, and the amplitude of 0.108 ± 0.012 ASM counts. The period of 400 days was discovered independently in [3] in the same data. Galloway et al. [6], however, identified another significant period of 383 days. The authors noted a similarity of V934 Her with the GX $1+4$ system, which has a very rich emission spectrum, hence, both systems are considered as similar-to-symbiotic.

Corbet et al. [10] analyzed the $RXTE/ASM$ data once more for the same epoch JD 2450087–2452383 (1996–2002), and did not confirm the presence of a 400-day and other significant periods.

2. OBSERVATIONS

We started our regular photoelectric UBV observations of V934 Her with the 0.6-m Zeiss reflector of the Crimean Station of the Sternberg State Astronomical Institute (SAI) straight after the 1997 outburst, we continue to observe the system ever since. The observations are performed with the UBV photometer designed by V. M. Lyutiy, and are homogeneous. All the observations were obtained by N. V. Metlova. We analyze here a series of 467 observations (302 nights) in the time range of JD 2450783–2455825. Current light curves and color indices are available for viewing with any Java-compatible browser in the Internet at `http://jet.sao.ru/~goray/v934her.htm`. The tables of observations are laid out in the same directory in the file *v934her.dat*. Besides the observations made at the Crimean Station of the SAI, the file includes observational data from two other literature sources. The columns of this file contain, respectively, the Julian dates in the format JD Hel.-2400000, the V, B, U, R values and a two-letter note, indicating the data source. During the observations, we used a comparison star GSC 2060-0124 ($17^h\, 06^m\, 15\overset{s}{.}05 + 23°50'\, 37''.9$; 2000), for which the following values were obtained: $V = 10.230$, $B = 10.803$, $U = 10.710$; and two control stars: GSC 2060-0622 ($17^h\, 06^m\, 22^s.46$ $+23°51'\ 54''\ .2$; 2000), and GSC 1985-0222 ($17^h\ 06^m\ 45^s.19\ +23°50'42''.9$; 2000), which confirm the brightness stability of the comparison star. The photoelectric measurements of GSC 2060-0622 and GSC 1985-0222 vary within the following ranges: V (11.57–11.60), B (12.65–12.66), U (13.61–13.70), and V (11.13–11.15), B (11.81–11.83), U (11.93–11.97), respectively.

For the needs of frequency analysis, we averaged all observations for one night, and if the number of observations was over 2, the standard deviation was computed. The accuracy of observations was determined as $0\overset{m}{.}005-0\overset{m}{.}009$ in the V filter, $0\overset{m}{.}008-0\overset{m}{.}013$ in the B filter, and $0\overset{m}{.}010-0\overset{m}{.}030$ in the U filter. Within these limits, the accuracy depended on the transparency of the sky, the elevation of the object above horizon, and the sky background (observations were also performed with the full moon).

The light curves of V934 Her in the V, B and U-bands in Fig. 1 are compared with an X-ray flux curve according to the $RXTE/ASM$ data. The limits of variability of V934 Her, measured in magnitudes in different filters are as follows: in the V filter they amount to 7.560–7.779, in the B filter: 9.141–9.379, and in the U filter: 11.003–11.361. Our observations do not cover the second X-ray outburst, the trigger of which was recorded by $RXTE/ASM$ on June 15, 2002 (JD 2452440), and the maximum about 40 days later [6]. The last date in this season of observations falls on JD 2452446 (6 days after the trigger), but the observations do not reveal any special features, neither do the observations [9] of the 1997 outburst. Our observations demonstrate a fast variability in the scale of a week, which was mentioned by the researchers earlier.

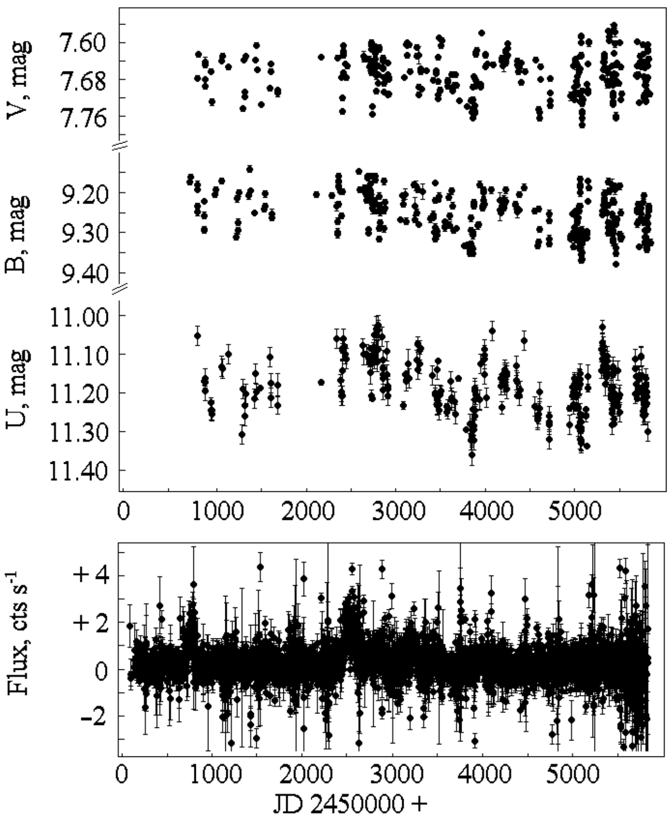

Fig. 1. The light curves of V934 Her in the V, B and U filters as compared with the curve of the X-ray flux at 2–10 keV, obtained with the ASM instrument of the $RXTE$ satellite. Two X-ray outbursts are visible arouund JD 2450780 and 2452520.

3. FREQUENCY ANALYSIS

For the frequency analysis of the observations we used the discrete Fourier transform for the time series with an arbitrary distribution of observations over time [11], and the `EFFECT` program, implementing this method (written by V. P. Goranskij). The Russian and English versions of the program, as well as the user instructions are laid out at `http://vgoray.front.ru/software`. To assess the significance of peaks in the amplitude spectrum, an empirical method of Terebizh [12] has been used. The method is based on the statistical study of artificial chaotic series, obtained by mixing the original series of observations, so that each value of a point in time from the original series is put in compliance with a random magnitude value, chosen from the same series. A comparison of peak values in the amplitude spectrum of the original series of observations with a probability of occurrence of peaks with different amplitudes in the corresponding random series allows to evaluate the significance levels of the periods found.

The amplitude spectra for the light curves of V934 Her in the V, B and U-bands are demonstrated in Fig. 2. We searched for periodicity in the range of 10–5000 days.

4. RESULTS OF ANALYSIS

The frequency analysis of the light curves of V934 Her demonstrates a complex pattern of periodic changes, which differ in various frequency bands. In the V-band, the amplitude spectrum reveals multiple peaks in the period range of 20–44 days with periodic components, having half-amplitudes of up to $0\overset{m}{.}024$. This range is dominated by the waves with periods of $28\overset{d}{.}5$, $31\overset{d}{.}4$ and $44\overset{d}{.}1$. The corresponding peaks in the spectrum have a complex and multi-component structure, indicating the variability of these periods. Such a spectrum is characteristic of red semiregular type-SRb variables in the classification of the General Catalogue of Variable Stars. The 404-day period, found from the spectroscopic observations [6], does not manifest itself in the V-band.

A peak of 406 days is visible in the amplitude spectrum of the light curve in the B-band in the region of low frequencies, close to the well-known spectroscopic period of 404 days. The difference is insignificant and lays within the measurement error of about 20 days. The half-amplitude of the corresponding wave amounts to $0\overset{m}{.}029$. A series of smaller amplitude peaks with periods similar to those detected in the V-band, $29\overset{d}{.}1$ and $44\overset{d}{.}0$, can be seen in the region of higher frequencies.

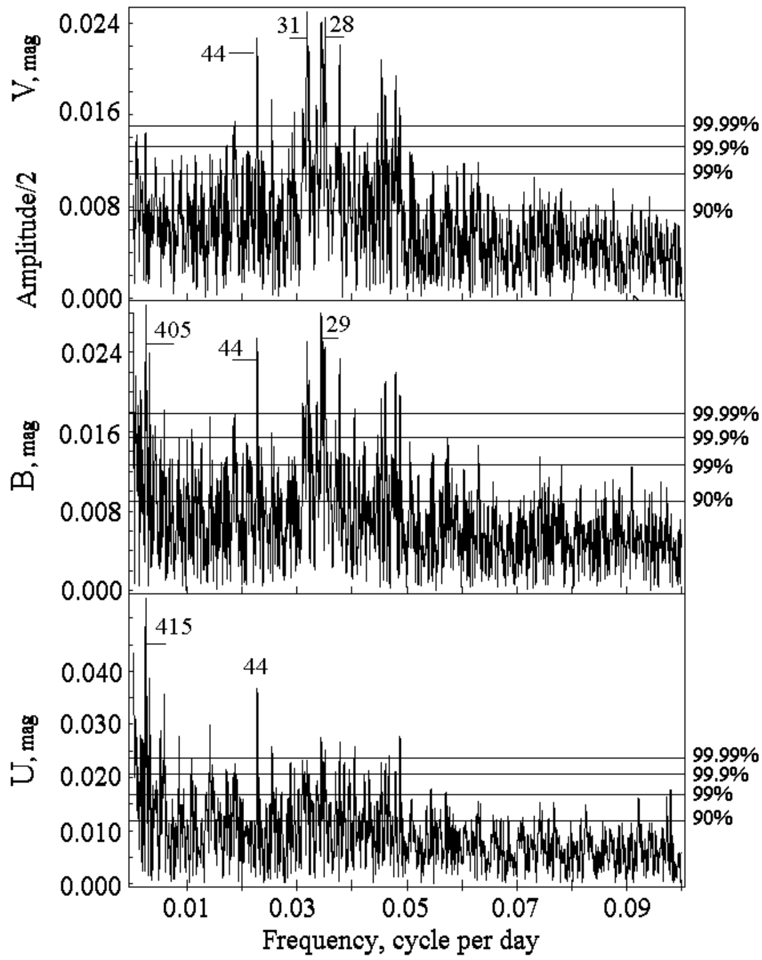

Fig. 2. The amplitude spectra of the three series of observations of V934 Her in the V, B and U-bands. The horizontal lines with percentages marked on the right are the peak significance levels. The largest peaks have the markings, indicating the periods in days.

The light curve in the U-band is dominated by a wave with a 415-day period, which is close to the known spectroscopic period of 404 days. The measurement accuracy of the 415-day period is ± 14 days. The difference between these periods is insignificant owing to the large irregular brightness variability. The half-amplitude of the wave amounts to $0\overset{m}{.}054$. In the UV region, only one wave with a period of $44\overset{d}{.}1$ is manifesting itself at high frequencies. Thus, we confirm the spectroscopic period of 404 days detected by Galloway et al. [6].

Figure 3 demonstrates the phase light curves of V934 Her in the V, B and U-bands. The lowest curve there describes the average phase curve of the flux at $2 - 10$ keV based on the current $RXTE/ASM$ data. Computing it via the moving average method, we used a large phase averaging interval of 0.2 and the linear elements

$$T_0 = 2449090 + 415^d \times E, \qquad (1)$$

where the epoch of periastron passage was taken as the coordinate origin, adopted from [6]. With these elements taken into account, the photometric maximum in the U-band is determined reliably and falls at the phase -0.07. This phase difference between the time of maximum and the time of periastron passage amounts to 29 days and is significant. The estimated epoch of the U-band maximum is JD 2455280 ± 20. The light curve in the U-band is slightly asymmetrical.

We have also computed the amplitude spectra of V934 Her using the latest $RXTE/ASM$ data[1] from September 1, 2011 (4800 averaged-per-day observations, with the data of two outbursts excluded) in the full time range of JD 2450087–2455805. The calculations were made in two variants: with and without the observations of two X-ray outbursts. In both cases, prominent peaks in the amplitude spectrum

[1] http://xte.mit.edu/ASM_lc.html

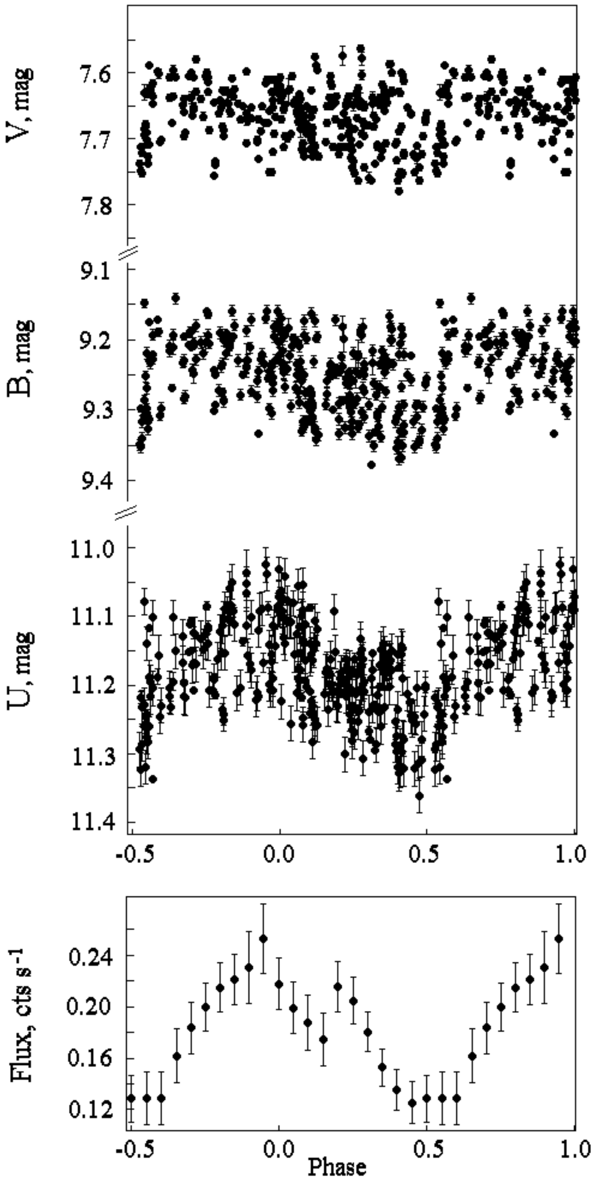

Fig. 3. The phase light curves of V934 Her in the V, B and U filters for the 415-day period from the elements of equation (1). The bottom plot demonstrates the averaged curve of the X-ray flux at $2-10$ keV according to $RXTE/ASM$, the phases of which are computed with the same elements.

are not associated with the spectroscopic period of 404 days. There are no significant peaks near the 415-day period either. Figure 3 (bottom plot) shows the average light curve based on the X-ray data, calculated with a period of 415 days (the outbursts are excluded from the calculations). However, there exists a notable periodic component with this period, and the maximum of the average light curve remains the same, as given in [6]. The total amplitude of this component is close to 0.1 ASM count per second, which is twice smaller than stated in [6].

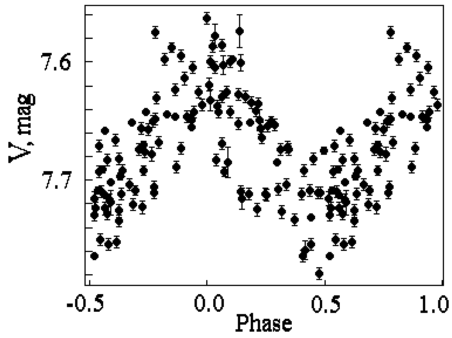

Fig. 4. The phase light curve for a wave with a period of $28\overset{\mathrm{d}}{.}82$ in the V filter based on the 2009–2011 observations, plotted with elements from (2).

To determine the nature of a more rapid variability, we examined a separate series of the past three seasons 2009–2011 (JD 2454942–2455825), which are most densely covered by observations. The light curves for this epoch reveal fluctuations of variable amplitude. The amplitude spectrum of this fragment of the series in the V-band is dominated by a peak, corresponding to the 28.82-day period with a sinusoidal light curve, having the half-amplitude of $0\overset{\mathrm{m}}{.}050$. The phase light curve in the V-band of this fragment is shown in Fig. 4. It is computed with the following linear elements:

$$\mathrm{Max} = 2455428.27 + 28\overset{\mathrm{d}}{.}823 \times E. \qquad (2)$$

There also exists a strong annual alias at 31.27 days with the wave half-amplitude of $0\overset{\mathrm{m}}{.}046$ which coincides with period, determined from the *Hipparcos* satellite database. The Fourier decomposition of the light curve revealed additional significant periodic components (the half-amplitudes of the periodic component are shown in brackets): $44\overset{\mathrm{d}}{.}19$ ($0\overset{\mathrm{m}}{.}030$), $63\overset{\mathrm{d}}{.}84$ ($0\overset{\mathrm{m}}{.}025$) and $21\overset{\mathrm{d}}{.}65$ ($0\overset{\mathrm{m}}{.}010$).

The quality of representation of original observations by the sum of waves of four identified periodic components can be seen in Fig. 5. This diagram makes it possible to classify the fast variability on the time scales of 20–44 days as the multiperiodic pulsations of the M star. Since these pulsations occur on the short time scale, the 415-day period can be considered as orbital.

Figure 6 demonstrates the color–magnitude diagrams V—$(U-B)$, U—$(B-V)$ and a two-color diagram $(U-B)$—$(B-V)$. We plotted the independent parameters along the axes of the color–magnitude diagrams. The color index variations are small: most of the observations are limited within the ranges of $\Delta(B-V) = 0\overset{\mathrm{m}}{.}1$, and $\Delta(U-B) = 0\overset{\mathrm{m}}{.}2$. There is a weak dependence of the $B-V$ color index on brightness: color becomes

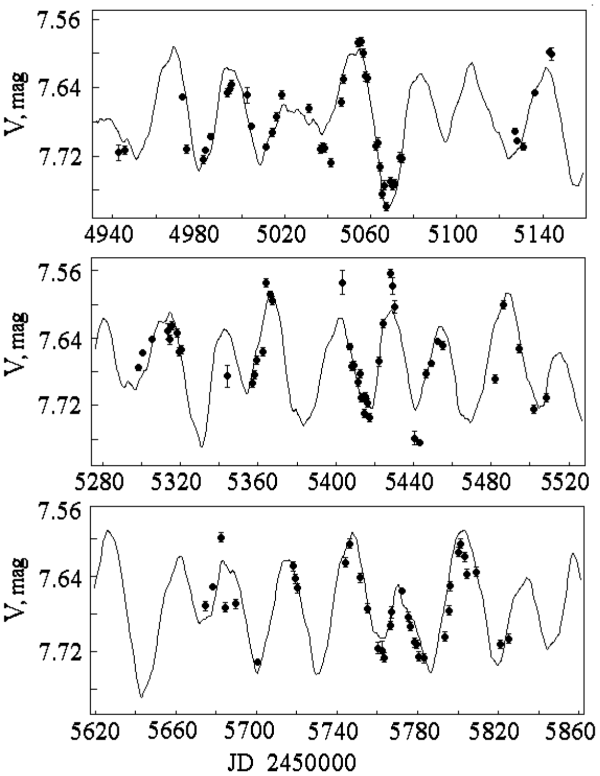

Fig. 5. Multiperiodic pulsations of V934 Her. Observations in the V filter are presented by the sum of 4 pulsation waves (the curve), identified in the Fourier expansion of the light curve.

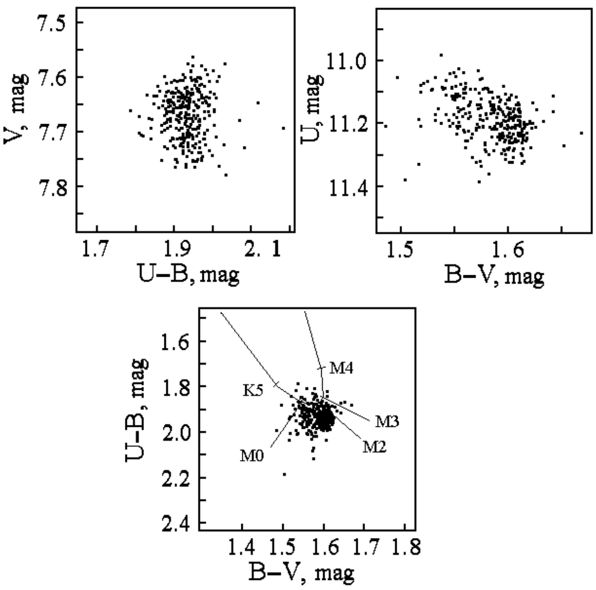

Fig. 6. Color–magnitude diagrams V—$(U-B)$, U—$(B-V)$ and a two-color diagram $(U-B)-(B-V)$. In the bottom diagram, we plotted a curve describing the sequence of luminosity class III red giants. The absence of ultraviolet excess of the M star with respect to normal stars can be seen.

slightly bluer with increasing brightness of the star in the U-band. The dependence between the two color indices is not noticeable. On the two-color diagram in Fig. 6 we plotted the curve, describing the sequence of red giants of luminosity class III with zero reddening. We used the data for normal stars of this sequence from [13]. The photometric data presented in this figure indicate that V934 Her has a zero interstellar reddening which confirms its close distance. In addition, no ultraviolet excess, which could have been formed by the accretion onto a neutron star is discernible. On the contrary, some ultraviolet deficiency is even noticeable with respect to normal stars, with the value of about $0\overset{m}{.}05$. Hence, the multicolor photometry does not show any features that would distinguish the M-giant in this system from the conventional M-giants of this luminosity class either.

5. THE V934 HER SPECTRUM

The optical spectrum of V934 Her was previously discussed in [3, 4, 6, 8, 9]. On April 6, 2006 at $23^h\,48^m$ UT we obtained a spectrum of the star at the 1-m Zeiss-1000 reflector of the SAO RAS with the *UAGS* spectrograph in the spectral range of λ 4478–7256 Å, and a 4 Å resolution. The observations were made through the thin cirri, and therefore we failed to calibrate the spectrum in absolute units.

Our spectrum was obtained on JD 2453832, at minimal brightness in the phase 0.43 of the 415-day period, if we count it from the light curve maximum in the U-band from the elements of (1). The spectrum is shown in Fig. 7. It demonstrates the TiO molecular absorption bands, and Hα (equivalent width EW = 0.79 Å), Hβ (EW = 0.45 Å) absorption lines. The Na I D_2D_1 (EW = 0.65 and 0.31 Å) doublet is obviously the stellar component, since this spectral feature is characteristic of cool stars. We also identified the lines of Ba II, Fe I, the triplet Mg I 5167, 5172 and 5183 Å in the absorption. These spectral lines are typical of M2 III stars.

Gaudenzi and Polcaro [8] reported that the 1995 and 1996 spectra of the Hα, Hβ, He I 5016, 5875 and 6867 Å lines reveal emissions of a peculiar shape, similar for all lines—a broad emission profile with a narrow central absorption [8, Fig. 2]. In our spectrum with the same spectral resolution, these lines bear resemblance with the lines from [8] even in minor details. However, we can not interpret them as emission lines, or having an emission component in the profiles, since the same features are observed in normal stars as well, e.g. an M3 III type star SAO 63349 [14]. As for the 6867 Å line, we identify with the atomic oxygen absorption band in the Earth's atmosphere.

Therefore, we have not found any emission lines in the optical spectrum, which could be formed in the accretion disk or in the cold atmosphere of the giant under the effect of the X-ray radiation.

6. DISCUSSION

V934 Her belongs to the rare class of SyXB symbiotic X-ray systems [15]. Among more than a hundred and fifty low-mass X-ray systems six of them are known: V934 Her (the object of the present study); V2116 Oph = GX 1 + 4 [16, 17]; 4U 1954+31 [18]; Sct X-1 [19]; IGR J16194–2810 [15] and 1XRS J180431.1–273932 [20]. Among these systems, only GX 1 + 4 revealed a complete set of typical properties of a symbiotic system: an M-giant with a variable blue continuum and a spectrum, rich in emission lines. Its emission shows H I, He I, Fe II, [Fe VII] and, possibly, [Fe X]. In several systems pulsations were discovered in X-rays from a rotating neutron star: V2116 Oph ($P_{\rm spin} = 120$ s); Sct X-1 ($P_{\rm spin} = 112$ s); 1RXS J180431.1–273932 ($P_{\rm spin} = 494$ s) [10]. The system 4U 1954+31 has revealed an X-ray period of 5.09 hours, which is interpreted as a rotation period of the neutron star [10].

V934 Her can not be attributed even to the classical symbiotic stars, since it lacks the blue continuum and the gas shell that radiates an emission spectrum. It is probably a wide pair with a compact component, which may be a neutron star. Judging on the spectrum, V934 Her belongs to the oxygen branch of cool stars. This means that V934 Her is a star with normal, close to solar, abundance of chemical elements. The period of rotation of the compact component is not detected in the X-ray range, although the quasi-periodic variations of X-ray radiation with a characteristic time scale on the order of 900 s were reported based on the *Einstein* satellite observations [5]. This is possibly due to the weakened magnetic field of the neutron star, or its complete absence. A number of X-ray observatories established that the object is observed continuously at a typical flux level of $(1 - 10) \times 10^{-11}$ erg cm^{-2} s^{-1} in the range of 2–10 keV. Moreover, X-ray outbursts occur in it [6].

In our work, we observed the pulsations in the optical range, but they refer to the red giant, rather than to the neutron star. At a distance of 420 pc the absolute magnitude $M_{\rm V}$ is estimated on the average as $-0\overset{\rm m}{.}47$, and with the bolometric correction BC $= -1\overset{\rm m}{.}65$ for M2 III type stars [13], the bolometric magnitude of the star amounts to $M_{\rm bol} = -2\overset{\rm m}{.}12$, and the luminosity is $L = 560 {\rm L}_{\odot}$. With such a low luminosity and small total amplitude of pulsations (about $0\overset{\rm m}{.}10$), the amount of matter released in the surrounding medium is too small to appear in the spectrum. Note for comparison that in the red supergiants (at $M_{\rm bol} = -7^m$) of the same spectral type, which are located on the top of the red giant branches in the nearby galaxies, and are still pulsating with the amplitudes of $3 - 7^m$ in the R-band, the mechanism of matter ejection in the circumstellar medium works very efficiently, and their spectra reveal strong Balmer emissions [21, 22]. In the IC 1613 and M33 galaxies such red supergiants have the pulsation periods of around 650^d. Obviously, as follows from the period–luminosity dependencies for red pulsating stars (see, e.g., [23]), V934 Her with its low luminosity cannot have a pulsation period of 404^d, hence, this period has a completely different nature.

As the results of the frequency analysis have shown, the 404-day period is detected only in the blue and ultraviolet rays. Figure 3 most clearly shows the wave with this period in the lower level of point distribution. Moreover, periodic changes with this period are clearly visible even in the V-band, where this period is not detected by the frequency analysis. Some small-mass X-ray systems reveal a similar phenomenon in the phase light curves, for example, in Cyg X-2 (V1341 Cyg). In this system at the lower activity level, a double wave (for the entire orbital period) is visible due to ellipsoidality of the secondary component, the accretion donor, when the contribution of the accretion disk is minimal and close to zero [24]. Moreover, in the low state, the color indices vary only slightly, just like in V934 Her. With an increase of contribution of the accretion disk in the activity state of the Cyg X-2 system, the brightness in different filters deviates upwards, while the color indices grow smaller.

V934 Her behaves somewhat differently. It has a solitary wave over the period. This is probably due to the ellipticity of the orbit of the neutron star. The deviations from the lower level go up owing to the pulsations of the red component, rather than because of the variable contribution of the accretion disk. There exist slight variations of color indices with the period of 415 days. We observe a systematic trend of the $B - V$ color index over time, namely, it grew $0\overset{\rm m}{.}04$ redder during the observation period. The light curves in Fig. 3 can be explained by additional emission of a hot continuum source, the contribution of which to the total luminosity of the system is very small and furthermore decreases with increasing wavelength, since it is veiled by the red star of a relatively high luminosity. It is yet unclear whether this source is in fact a region on the surface of the M star, closest to the neutron star. In this case, the hard X-ray and ultraviolet radiation of the neutron star and its surroundings will interact with the cold molecular gas

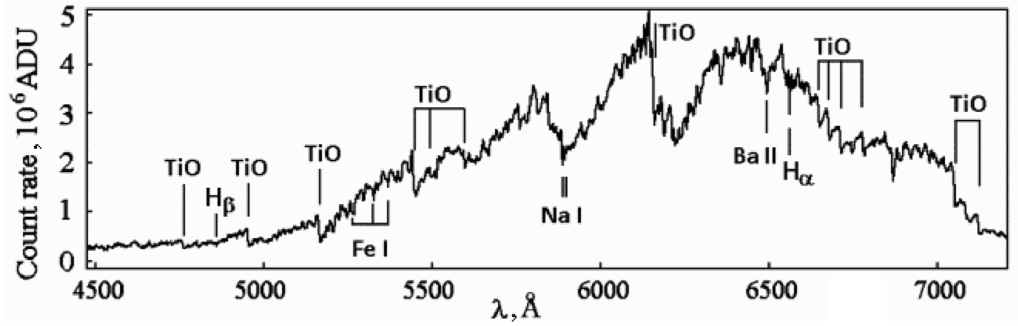

Fig. 7. The spectrum of V934 Her. The CCD analog-digital units, and wavelength in angstroms are plotted along the ordinate and abscissa axis, respectively.

from the outer layers of the envelope of the M star. It is likely that the hard radiation is none the less warming a part of the surface of the red giant from the direction of the incident flux, hence forming a warm spot, which has an earlier spectral type. Emission from this spot, imposed on the cold molecular spectrum will make a significant contribution only in the short range of the optical spectrum.

The authors of this study were able to obtain important and challenging observations of such an interaction during a well-known event in the system of a peculiar red nova V838 Mon. This system has undergone a convergence, and even a capture and engulf of a hot B3V type star by a cool component of the late M type, a remnant of the red nova outburst [25, 26]. In that case, at a considerable separation of the B star, forbidden weak emissions of the ions of iron [Fe II] 4244.0, 4287.4, 4359.3, 4413.8, 4814.6 Å and the 4452.1/4458.0 Å blend have appeared as soon as two years prior to the collision and capture in the blue spectral region. This implies that the radiation of the approaching hot star started to ionize the rarefied stellar wind, while in no way affecting the molecular spectrum of the atmosphere of the red giant. We believe that the traces of these emissions are worthwhile to be searched for in the high-resolution spectra of V934 Her in the phases of the 415-day period near the maximum light in the ultraviolet.

The study of emissions in the far ultraviolet part of the spectrum is of great interest, namely: the C IV 1550 Å, N V 1238 Å and Mg II 2800 Å lines, which are not usually found in M-giants, but are visible and variable in V934 Her [4, 7]. There may exist a dependence of intensities of these emissions on the phase of the 415-day period.

The sought-for source of the X-ray radiation in the V934 Her system may be the accretion of rarefied gas onto a neutron star from the stellar wind of the red giant [3]. Most likely, this is the energy, released in the collision of a weak flow of the wind with the surface of the neutron star. The hydrogen burning on the surface of neutron stars is a nonstationary process, as it requires the accumulation of a critical mass. An explosion of a critical mass of hydrogen usually results in X-ray outbursts. In some cases, the stationary hydrogen burning is possible in the magnetic poles of neutron stars. In this case, however, we should expect a significant modulation of the optical and X-ray emission with the rotation period of the neutron star, which is not confirmed in observations. In our opinion, the X-ray outbursts in the system may be also related with the infall of cometary nuclei onto the neutron star, similar to those, existing in the vicinity of the solar system and regularly hitting the Sun. The V934 Her system may have its own "Oort cloud" lying around it. The capture of such objects by the binary system components is more probable than the capture by a single star.

7. CONCLUSIONS

Based on multicolor *UBV* observations, we have discovered a 415-day period which is close to the spectroscopic period, found in [6] from radial velocities of the red giant. This period is the orbital period of motion of the neutron star around the cool M2 III type component. We also detected the multi-periodic pulsations of the cool component.

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