Astron. Astrophys. 338, 1006–1014 (1998)

ASTRONOMY
AND
ASTROPHYSICS

Spectral evolution of Nova (V 723) Cassiopeiae 1995: pre-maximum stage*

T. Iijima[1], **L. Rosino**[2], **and M. Della Valle**[3]

[1] Astronomical Observatory of Padova, Asiago Section, Osservatorio Astrofisico, I-36012 Asiago (Vi), Italy
[2] Department of Astronomy, University of Padova
[3] Department of Astronomy, University of Padova, Vicolo dell'Osservatorio 5, I-35122 Padova, Italy

Received 29 May 1998 / Accepted 29 July 1998

Abstract. The monitoring of spectral evolution of the very slow nova V723 Cas started at the Asiago Astrophysical Observatory just on the announcement of discovery. In this paper the spectral evolution during the long pre-maximum stage, which lasted from August to December 1995, is reported. Emission lines of H I and Fe II were prominent in the early stage. Most of the lines were accompanied by P Cygni type absorption components. The emission lines gradually weakened with time and the absorption components developed. The mean of the blue-shifts of the absorption components with respect to the emissions was about -126 km s^{-1} in September and -96 km s^{-1} in December 1995. Some lines of Fe I, Fe II, Y II, Sc II, Ba II, etc. appeared in the later stage. All emission lines, except for Hα, once nearly disappeared in November when the nova slightly brightened to V$\simeq$8.6. Some emission lines appeared again several days before the beginning of the final rise to maximum luminosity, then a pure absorption spectrum of F type supergiant was seen on the maximum of V$\simeq$7.1 at the middle of December. The absorption components of Si II lines at 634.7 and 637.1 nm showed fairly different profiles from those of the other metallic lines, which suggests a complicated gas motion in the atmosphere. The distance and the absolute magnitude at maximum are estimated to be 2.95$\pm$0.7 kpc and $\mathrm{M_V(max)} = -6.1 \pm 0.5$, respectively. The mass of the white dwarf in this system may be about 0.58$\pm$0.07 $\mathrm{M_\odot}$.

Key words: stars: individual: V 723 Cas – stars: novae, cataclysmic variables

1. Introduction

Nova Cas 1995 (V723 Cas) was discovered by M. Yamamoto (IAU Circ. 6213) on 1995 August 24 as a star of magnitude 9.2. The monitoring of spectral evolution of this object started in our observatory just on the announcement of discovery. Some preliminary reports have been made by Iijima and Rosino (IAU Circulars 6214, 6365, 6703), by Della Valle et al. (IAU Circular 6214) and by Munari et al. (IAU Circulars 6259, 6284).

The unusually slow evolution of this nova has been reported in some previous works. For example, about two years passed from the light maximum to the beginning of nebular stage (Iijima & Rosino 1997). This time is roughly twice of the known slowest classical novae such as RR Pic (Lunt 1926; Spencer 1931) and HR Del (e.g. Hutchings 1971; Sanyal 1974; Yamashita 1975; Rafanelli & Rosino 1978). Some theoretical works (e.g. Kovetz & Prialnik 1985; Livio 1992; Kato & Hachisu 1994) have suggested that such slowest explosions occur on white dwarfs of which masses are close to the lower limit to perform the explosions ($\mathrm{M_{WD}} \sim 0.6\,\mathrm{M_\odot}$). Detailed studies of this nova, therefore, may be important to advance our knowledge about the critical condition of novae's explosions. In this paper we present the results of spectroscopic works carried out during the long pre-maximum stage which lasted from August to December 1995. The distance to the nova, the absolute magnitude at maximum luminosity, and the mass of the white dwarf are estimated.

2. Observations

The high dispersion spectra were obtained on the 182 cm telescope of Mount Ekar station of the Astronomical Observatory of Padova with an Echelle spectrograph and a 550×550 pixel CCD detector. The spectra covered the range from 430 to 680 nm by a resolution of about 0.06 nm. The medium dispersion spectra were obtained on the 122 cm telescope of the Asiago Astrophysical Observatory of the University of Padova using a prismatic spectrograph Camera VI which covered the range from 380 to 830 nm changing the angle of the prism. A 512×400 pixel CCD was used as detector. The spectral resolution was 0.5 nm at Hγ, 1 nm at Hβ, and 3 nm at Hα. Some additional medium dispersion spectra (resolution 0.6 nm) were taken with a Boller & Chivens spectrograph mounted on the 182 cm telescope.

The spectra were reduced in the standard ways using the NOAO IRAF package at the Asiago Observatory. The sensitivity of the spectrographs were corrected using spectra of spectrophotometric standard stars obtained in the same nights. Hiltner 102 was used for the reduction of the medium dispersion

---

Send offprint requests to: T. Iijima, (iijima@astras.pd.astro.it)

* Table 5 is only available in electronic form at CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http:// cdsweb.u-strasbg.fr/Abstract html

Table 1. Spectroscopic observations of V723 Cas in 1995

Date		U.T.	JD	Exp.	Instr.	Spectral	Comments
		h m	(2400000+)	min.		Range (nm)	
Aug.	26	22 52	49956.46	10	C–VI	411 – 511	cloudy
Aug.	26	23 23	49956.48	10	”	411 – 511	cloudy
Aug.	26	23 46	49956.49	5	”	482 – 714	cloudy
Sep.	1	3 03	49961.63	10	”	421 – 534	
Sep.	6	2 51	49966.62	10	”	411 – 511	
Sep.	12	3 27	49972.65	15	Echelle	430 – 680	thin cloud
Sep.	21	2 30	49981.61	10	C–VI	411 – 511	
Sep.	21	3 38	49981.65	5	”	482 – 714	
Sep.	27	2 22	49987.60	10	”	411 – 511	
Sep.	27	4 01	49987.67	5	”	482 – 714	
Oct.	7	1 52	49997.58	10	”	411 – 511	
Oct.	13	1 35	50003.57	15	Echelle	430 – 680	
Oct.	17	2 01	50007.59	10	C–VI	411 – 511	
Oct.	20	2 27	50010.60	5	”	482 – 714	
Oct.	24	2 56	50014.63	10	”	421 – 534	
Oct.	28	23 12	50019.47	2	B&C	572 – 686	
Oct.	29	0 05	50019.51	5	”	403 – 517	
Nov.	20	22 07	50042.43	10	C–VI	411 – 511	
Nov.	20	23 24	50042.48	5	”	482 – 714	
Nov.	21	23 12	50043.47	10	”	388 – 460	
Nov.	23	22 06	50045.42	10	”	388 – 460	
Nov.	23	23 48	50045.49	5	”	428 – 551	
Nov.	24	0 58	50045.54	2	”	513 – 810	
Dec.	2	23 58	50054.50	10	”	411 – 511	
Dec.	4	22 32	50056.44	10	Echelle	430 – 680	
Dec.	6	0 25	50057.52	15	”	430 – 680	thin cloud
Dec.	10	19 57	50062.33	5	C–VI	411 – 511	
Dec.	10	20 04	50062.34	10	”	411 – 511	
Dec.	19	19 53	50071.33	5	”	411 – 511	
Dec.	19	20 00	50071.33	2	”	411 – 511	

Exp.: Exposure time

spectra and HD17520 was used for the high dispersion spectra. A journal of the observations is given in Table 1.

3. Light curve

Light curves of this nova have been given in some previous works (e.g. Munari et al. 1996; Ohsima et al. 1996) and are presented also on some pages of world wide web., e.g. by Stig Linander. To meet the convenience of the readers, however, we present the light curve and colours in Fig. 1. The V magnitudes are mainly due to the material prepared by Stig Linander on the *www.*, and some other data given in IAU Circulars are added. The UBV photometric data were obtained by Russian astronomers (E.A. Karitskaya, N.V. Metlova, S. Yu. Shugarov, etc.) and were supplied on VSNET by V. Goranskij.

The first rising of the nova from a minimum about V$\sim$18 (Williams 1995) to V$\sim$11 very likely took place from JD2449928 to 30 (1995 July 29–31). Then after somewhat slowing, the nova reached a semi-steady V magnitude of about 9, rising during November at almost 8.6 and suddenly, at the beginning of December, from 8.5 to a maximum of V$\simeq$7.1 on December 17 (JD2450069)[1].

4. Medium dispersion spectra

The first spectra were taken on 1995 August 26, when the nova reached the semi-steady level of V$\simeq$9. Figs. 2 and 3 show the spectra in the blue and red regions. Unfortunately, because of cloudy sky, the spectrophotometric calibration was not applied. Prominent emission lines of H I and Fe II and some weak lines of Ti II, Mg II, and Cr II were seen on the blue spectrum (Fig. 2), while the red one showed a prominent emission of Hα, some emission lines of Fe II, and the absorptions of Si II at 634.7 and 637.1 nm (Fig. 3). As will be seen in the next section, the absorption of Na I D1+D2 in this stage was mainly interstellar origin. Numerous lines were accompanied by weakly blue-shifted absorption component. Nearly the same spectral feature was seen on 1995 September 6 (Fig. 4), where the unit of ordinate is

---

[1] The seven lines presented here are due to a manuscript left by the late Prof. L. Rosino

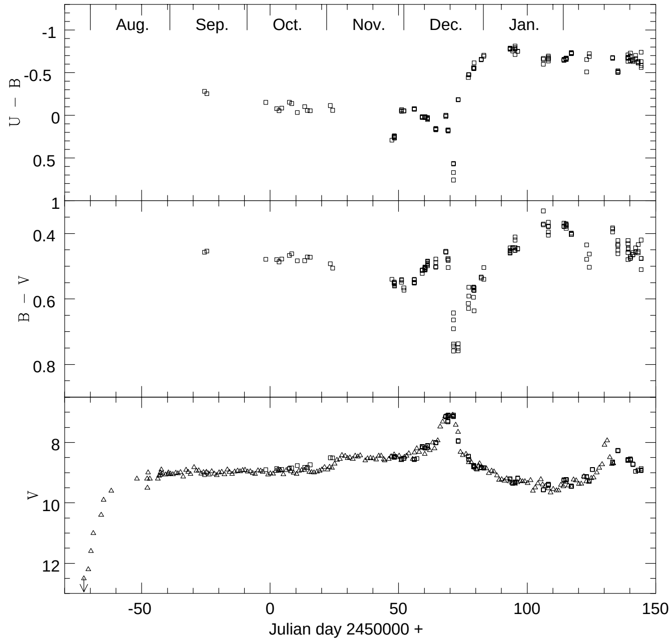

Fig. 1. Light curve and colours of V723 Cas. The data were prepared mainly by Stig Linander and by V. Goranskij

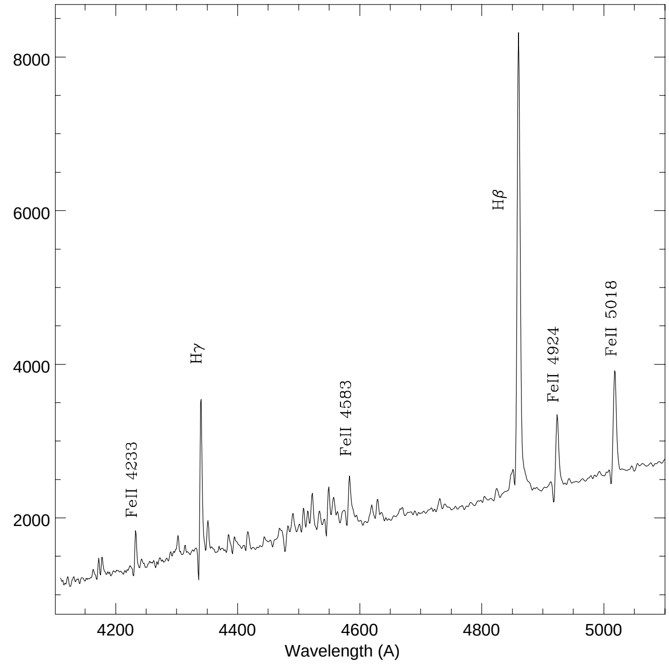

Fig. 2. Spectrum of V723 Cas on 1995 August 26. Flux calibration is not applied

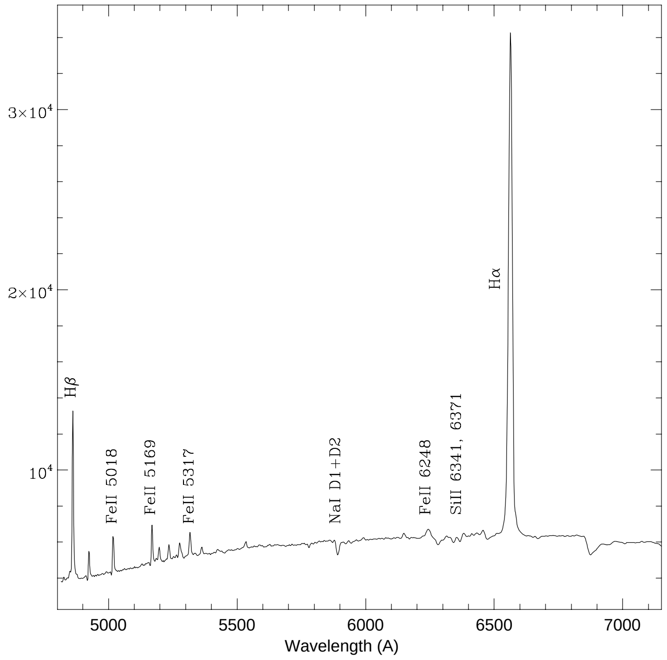

Fig. 3. Spectrum of V723 Cas on 1995 August 26. Flux calibration is not applied

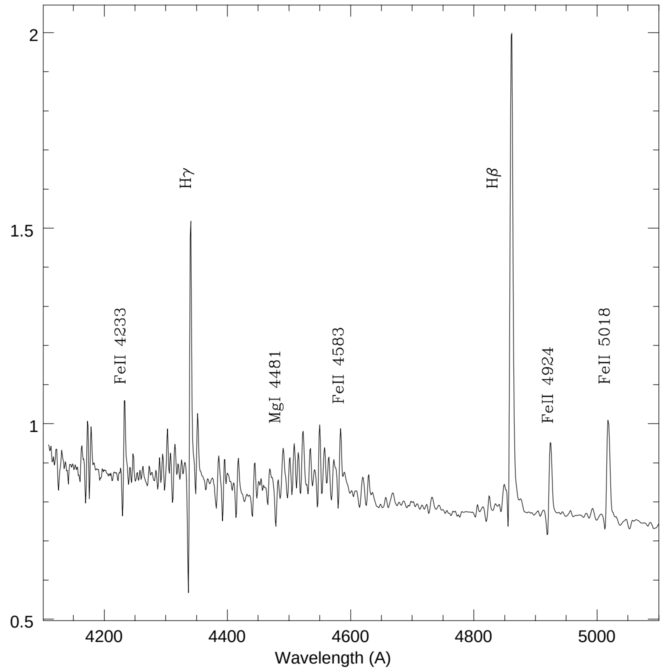

Fig. 4. Spectrum of V723 Cas on 1995 September 6. Unit of ordinate is 10^{-12}erg cm^{-2}sec^{-1}Å^{-1}

10^{-12} erg cm^{-2}sec^{-1}Å^{-1}. The same unit is used also in the successive medium dispersion spectra.

Significant variations were not seen on the V magnitude and colours until the end of October (Fig. 1). During the same time the emission lines gradually weakened and the absorption components developed. A spectrum in the blue region obtained on October 17 is shown in Fig. 5. In November, when the luminosity rose to V≃8.6 (Fig. 1), the absorption components well developed. Only Hα was in prominent emission in November 20∼24. Spectra on November 20 are shown in Figs. 6 and 7, where Hβ and Fe II at 492.4, 501.8 and 516.9 nm were deep absorptions with weak traces of emission. Prior to the final rising to the principal light maximum, the emission lines of Hβ and Fe II appeared again at the beginning of December. A spectrum

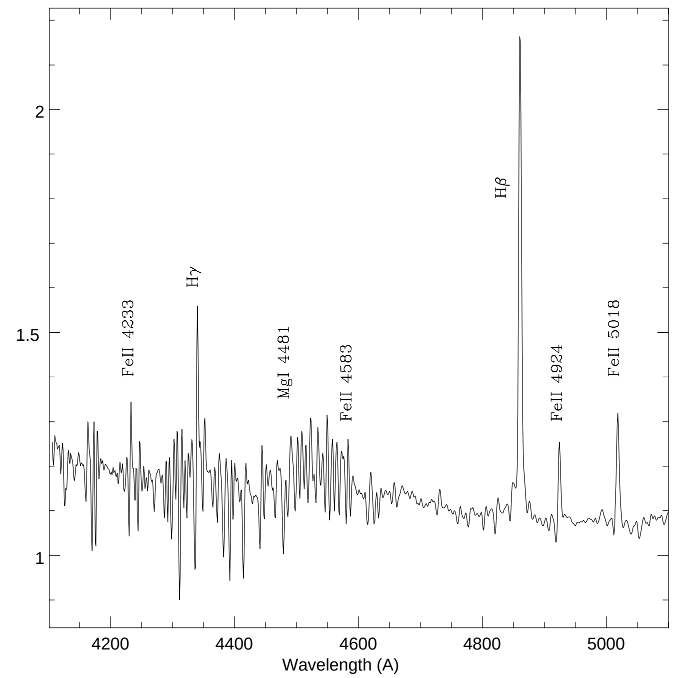

Fig. 5. Spectrum of V723 Cas on 1995 October 17

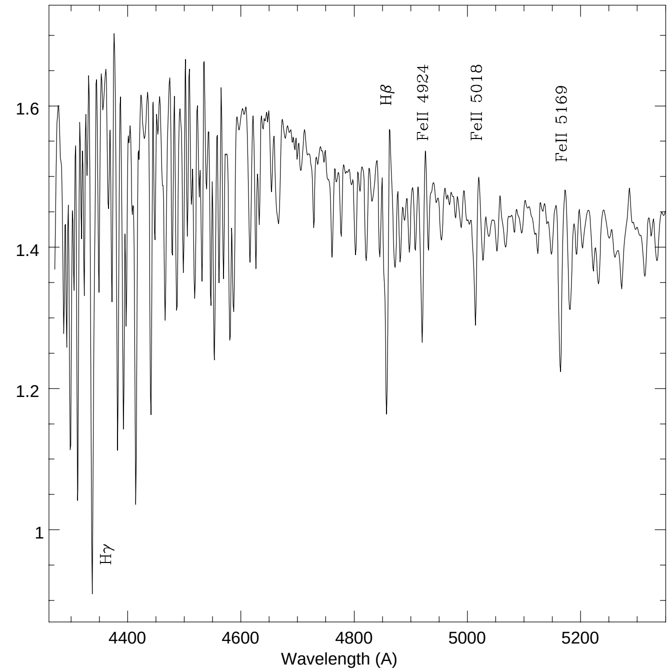

Fig. 6. Spectrum of V723 Cas on 1995 November 23

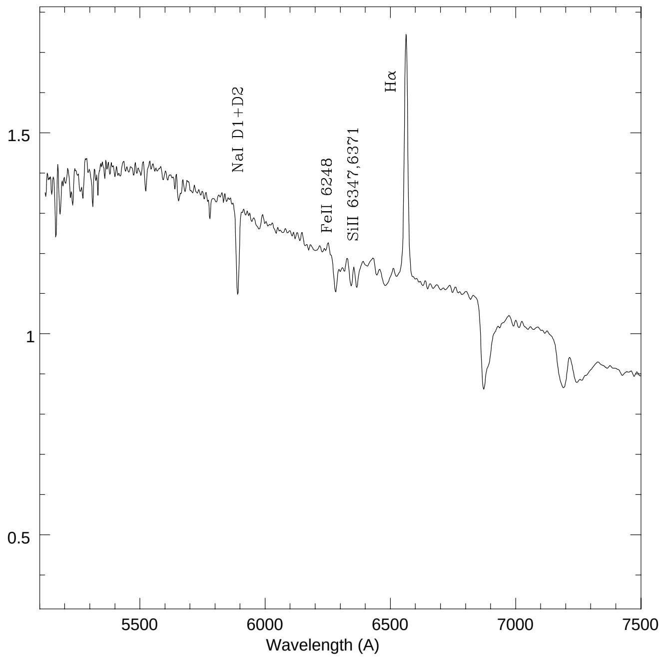

Fig. 7. Spectrum of V723 Cas on 1995 November 23

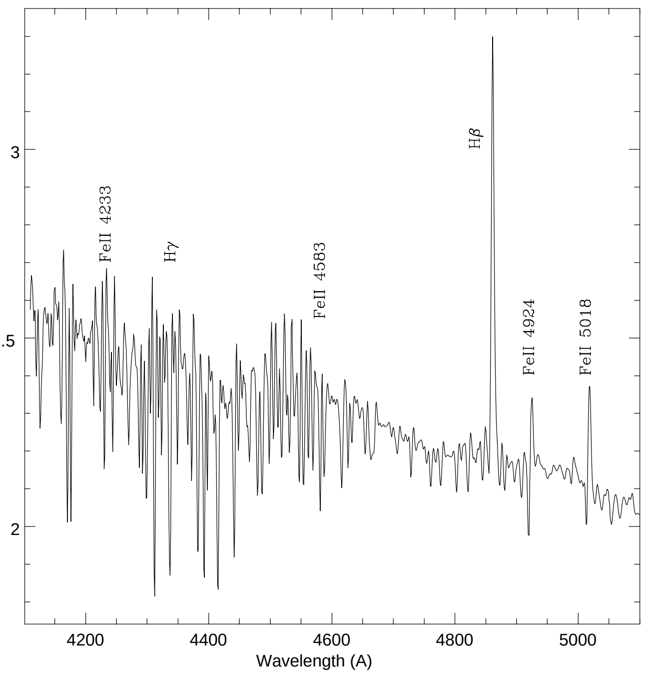

Fig. 8. Spectrum of V723 Cas on 1995 December 10

on December 10 is shown in Fig. 8. A pure absorption spectrum was found at the maximum luminosity on December 19 (Fig. 9). Unfortunately, the region of Hα was not observed during the light maximum. A spectrum of an F type supergiant HR 382 (F0 Ia) obtained with the same instrument is shown in Fig. 10. It may be possible to see that the spectrum of the nova at the maximum luminosity was nearly identical with that of the F type supergiant.

It is obvious from the high dispersion spectroscopy, which are presented in the next section, that most of the emission and absorption components in the medium dispersion spectra were blends of several lines. The equivalent widths of these components should have only restricted physical meanings. We have measured equivalent widths of a few selected lines which were relatively free from blending. The results are given in Table 2. These values may be used as a rough measure for strength of the

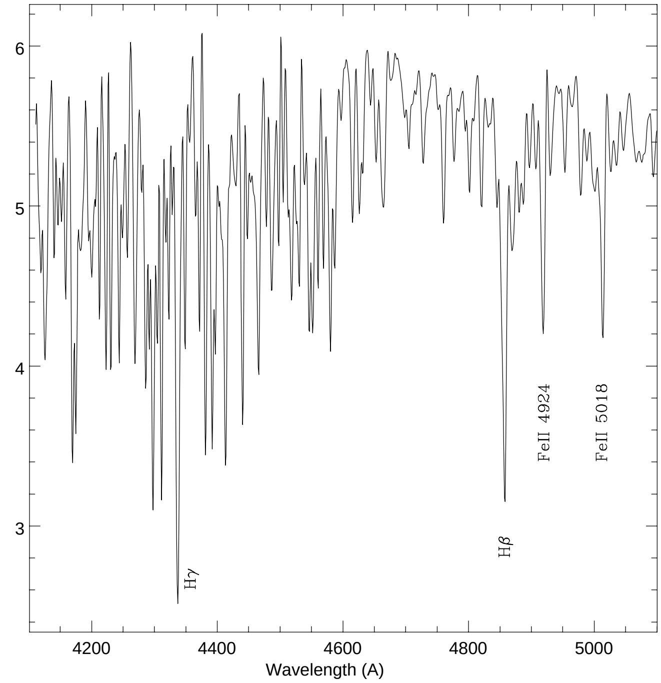

Fig. 9. Spectrum of V723 Cas on 1995 December 19 (at light maximum)

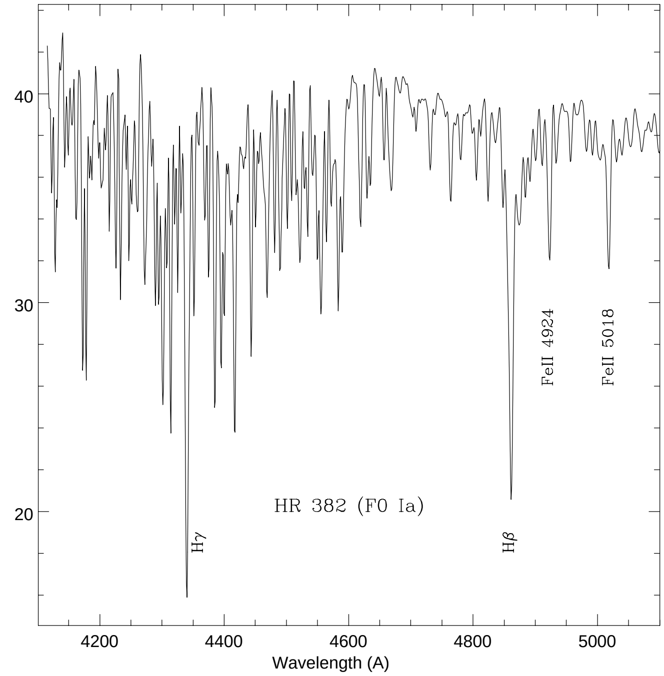

Fig. 10. Spectrum of HR 382 (F0 Ia) obtained with the same instrument of V723 Cas

emission and absorption components. Mean radial velocities of the absorption components of Fe II lines at 417.3, 417.9, 423.3, 431.4 and 454.9 nm are also given in Table 2. The observational error in the equivalent widths is about $\pm 10\%$ and that in the mean radial velocities is about ± 10 km s^{-1}.

5. High dispersion spectra

Tracings of some selected regions of high dispersion spectra obtained on 1995 September 12, October 13 and December 4 are shown in Figs. 11$\sim$14. One more spectrum was taken on December 6, which is, however, not presented here, because it was effectively the same as that of December 4. Unit of ordinates is 10^{-12}erg cm^{-2}sec^{-1}Å^{-1}, but, because of the distortion of the spectra, there is large ambiguity in the absolute intensities of the high dispersion spectra.

Heliocentric radial velocities of emission and absorption components of some selected lines are given in Table 3, and their equivalent widths are given in Table 4. The observational error in the radial velocities is about ± 1 km s^{-1} and that in the equivalent widths is about $\pm 10\%$. Wavelengths, equivalent widths, and identifications of all emission and absorption components in the spectra of September 12 and December 4 are presented in Table 5.

Hutchings (1971) observed multiple absorption components of Hγ in the early stage of evolution of HR Del. Such a feature was not detected on the H I lines (Figs. 11 and 12) in our high dispersion spectra. The absorption line in the blue-ward side of Hγ should be identified as Ti II at 433.79 nm. Some lines of Fe II seem to have had multiple absorption components. For example, Fe II at 641.7 nm may have had three absorption components on September 12 and December 4, which are indicated by lines in Fig. 14. The blue-shifts of these three absorption components with respect to the emission component were -179.0, -144.4, and -102.8 km s^{-1} on September 12 and -157.9, -111.2, and -75.7 km s^{-1} on December 4. The multiple absorption components, however, were not common among Fe II lines. As seen in Fig. 12, Fe II at 492.4 nm didn't show such a profile. Both Fe II lines at 641.7 and 645.6 nm depend on the same multiplet No. 74, but the line at 645.6 nm had only two absorption components whose blue-shifts were -169.1 and -119.4 km s^{-1} on September 12 and -148.2 and -103.6 km s^{-1} on December 4.

Large changes of profile were seen on the absorption components of Si II lines at 634.7 and 637.1 nm (Fig. 14). In contrast to the other lines, Si II had well separated two absorption components on September 12. The same lines had only one absorption component on October 13, then the double absorptions appeared again on December 4 (Fig. 14). Since the excitation potentials of these lines are higher than those of the other metallic lines, Si II lines may have been formed in a deeper region of the atmosphere. The large difference between the profiles of Si II lines and those of the other metallic lines suggests a complicated motion in the atmosphere of the nova. The real motion in the atmosphere seems to be different from a simple acceleration or deceleration.

Some new lines of low excitation potential appeared at later stages. For example, no trace of absorption nor emission of Ba II at 493.4 nm and Y II lines at 488.4 and 490.0 nm was seen on September 12 (upper panel of Fig. 12), whereas weak traces of these lines were seen in absorption on October 13 then they were prominent absorptions on December 4 (lower panel of Fig. 12).

Table 2. Equivalent width in Å of three selected Fe II lines and mean radial velocity of absorption components of five Fe II lines (see text) measured on the medium dispersion spectra

JD	4233		4419		4923		R.V.
(2400000+)	em.	ab.	em.	ab.	em.	ab.	km s^{-1}
49956.48	–1.25	0.10	–0.75	0.0	–2.10	0.31	–269
49961.63	–1.05	0.17	–0.40	0.12	–1.65	0.23	–275
49966.62	–0.79	0.29	–0.30	0.20	–1.20	0.20	–256
49981.61	–0.81	0.28	–0.42	0.27	–1.09	0.17	–236
49987.60	–0.44	0.22	–0.38	0.36	–0.80	0.17	–223
49997.58	–0.43	0.30	–0.21	0.63	–0.68	0.26	–197
50007.59	–0.31	0.27	–0.15	0.55	–0.76	0.15	–218
50014.63	–0.19	0.25	–0.07	0.57	–0.41	0.23	–195
50019.51	–0.21	0.14	–0.18	0.36	–0.72	0.26	–208
50042.43	0	0.57	0	1.31	–0.17	0.78	–217
50043.47	0	0.56	0	1.39			–216
50045.45	0	0.67	0	1.5	–0.11	0.75	–177
50054.50	–0.06	0.48	0	1.25	–0.35	0.49	–164
50062.34	–0.11	0.41	0	0.90	–0.37	0.31	–173
50071.33	0	1.39	0	2.36	0	1.98	–203

Table 3. Radial velocities in km s^{-1} of emission (em.) and absorption (ab.) components of selected lines of V723 Cas

element		λ (Å)	Sep. 12		Oct.13		Dec. 4		Dec. 6	
Ion	mult.		em.	ab.	em.	ab.	em.	ab.	em.	ab.
Hγ		4340	–62.3	–205.3	–54.6	–167.9	–61.9	–162.8	–58.4	–162.6
Fe II	27	4352	–60.6	–190.9	–64.8	–170.9	–63.8	–175.4	–55.5	–167.8
Ti II	31	4501	–59.6	–184.8	–59.2	–162.4	–64.4	–147.7	–57.5	–150.8
Fe II	38	4508	–62.8	–189.2	–62.4	–162.1	–60.4	–162.1	–54.1	–161.9
Ti II	82	4572	–57.2	–177.8	–56.3	–157.2	–55.9	–147.7	–53.6	–145.5
Fe II	37	4629	–54.4	–183.9	–51.6	–154.6	–49.6	–153.2	–46.1	–143.2
Ti II	92	4780	–59.8	–189.0	–65.6	–159.6	–56.3	–141.6	–49.6	–137.4
Cr II	30	4848	–39.6	–181.2	–61.5	–155.5	–32.9	–152.9	–41.7	–153.6
Hβ		4861	–47.5	–201.7	–49.0	–168.6	–52.0	–151.9	–49.6	–150.2
Cr II	30	4876	–56.5	–164.1	–60.3	–153.7	–50.0	–160.7		
Y II	22	4900				–163.4	–38.9	–142.8	–41.0	–138.3
Fe II	42	4924	–47.9	–179.4	–51.4	–153.7	–54.6	–143.5	–52.9	–140.0
Ba II	1	4934					–48.5	–141.4	–49.2	–139.7
Fe II	42	5018	–51.6	–182.4	–55.7	–156.1	–57.6	–144.8	–54.6	–140.7
Fe II	48	5363	–59.2	–183.9	–64.8	–156.4	–61.9	–163.1	–56.7	–145.6
Na I	1	5890		–177.0		–154.9		–148.9		–146.9
Na I	1	5896		–176.3		–157.2		–153.8		–149.3
Si II	2	6347	–36.3	–221.0	–50.9	–159.0	–50.9	–195.9	–46.4	–199.4
Si II	2	6347		–150.1				–123.6		–119.6
Si II	2	6371	–32.3	–228.1	–37.5	–144.3	–44.2	–221.6	–41.6	–221.8
Si II	2	6371		–113.8				–114.8		–107.9
Fe II	74	6456	–64.3	–178.5	–67.6	–160.5	–69.9	–177.6	–65.4	–168.0
Hα		6563	–58.5	–248.1	–56.4	–203.5	–58.1	–170.5	–56.9	–163.8

The new born lines were mainly due to Fe I, Fe II, Ba II, Sc II, Y II, etc. (Table 5), which suggests a decreasing of temperature of the photosphere.

The interstellar absorption components of Na I D1 and D2 lines were much deeper than the stellar ones in September (upper panel of Fig. 13), then the stellar absorption and emission components strengthened in October. Equivalent widths of the emission components were not measured, because they were blended with the interstellar components. The stellar absorption components became deeper and slightly wider in December (lower panel of Fig. 13). The asymmetry of the profile of the absorptions of Na I D1 and D2 on December 4 suggests an emergence of a new high velocity component. Radial velocities of the interstellar components of Na I D1 and D2 lines are -21.4 ± 1 and -23.2 ± 1 km s^{-1}, respectively and their equivalent widths are 0.57 ± 0.02 and 0.69 ± 0.02 Å.

Table 4. Equivalent widths in Å of emission (em.) and absorption (ab.) components of selected lines of V723 Cas

element		λ (Å)	Sep. 12		Oct.13		Dec. 4		Dec. 6	
Ion	mult.		em.	ab.	em.	ab.	em.	ab.	em.	ab.
Hγ		4340	–2.82	0.92	–1.18	0.90	–0.19	0.90	–0.37	0.74
Fe II	27	4352	–0.61	0.46	–0.42	0.53	–0.21	0.64	–0.30	0.47
Ti II	31	4501	–0.24	0.56	–0.43	0.58	–0.33	0.67	–0.42	0.60
Fe II	38	4508	–0.29	0.47	–0.30	0.47	–0.21	0.48	–0.28	0.39
Ti II	82	4572	–0.26	0.64	–0.38	0.63	–0.29	0.68	–0.47	0.52
Fe II	37	4629	–0.55	0.31	–0.30	0.49	–0.25	0.50	–0.28	0.39
Ti II	92	4780	–0.10	0.08	–0.11	0.22	–0.10	0.28	–0.12	0.28
Cr II	30	4848	–0.25	0.14	–0.22	0.31	–0.23	0.27	–0.23	0.23
Hβ		4861	–7.28	1.01	–4.50	0.97	–2.32	1.02	–2.53	0.74
Cr II	30	4876	–0.19	0.06	–0.20	0.16	–0.15	0.10	–0.16	0.11
Y II	22	4900				0.06	–0.09	0.25	–0.04	0.21
Fe II	42	4924	–1.68	0.75	–1.00	0.74	–0.75	0.80	–0.84	0.74
Ba II	1	4934				0.03	–0.12	0.27	–0.04	0.19
Fe II	42	5018	–2.21	0.71	–1.23	0.76	–0.87	0.71	–0.86	0.64
Fe II	48	5363	–0.58	0.13	–0.52	0.32	–0.42	0.27	–0.51	0.19
Na I	1	5890		0.32		0.56		0.69		0.55
Na I	1	5896		0.23		0.48		0.76		0.56
Si II	2	6347	–0.22	0.47	–0.09	0.64	–0.09	0.33	–0.08	0.33
Si II	2	6347		0.26				0.18		0.22
Si II	2	6371	–0.17	0.36	–0.04	0.45	–0.07	–0.20	–0.08	0.24
Si II	2	6371		0.22				0.17		0.14
Fe II	74	6456	–0.96	0.22	–0.79	0.39	–0.81	0.24	–0.84	0.21
Hα		6563	–32.1	0.61	–17.1	0.95	–12.9	0.69	–10.4	0.97

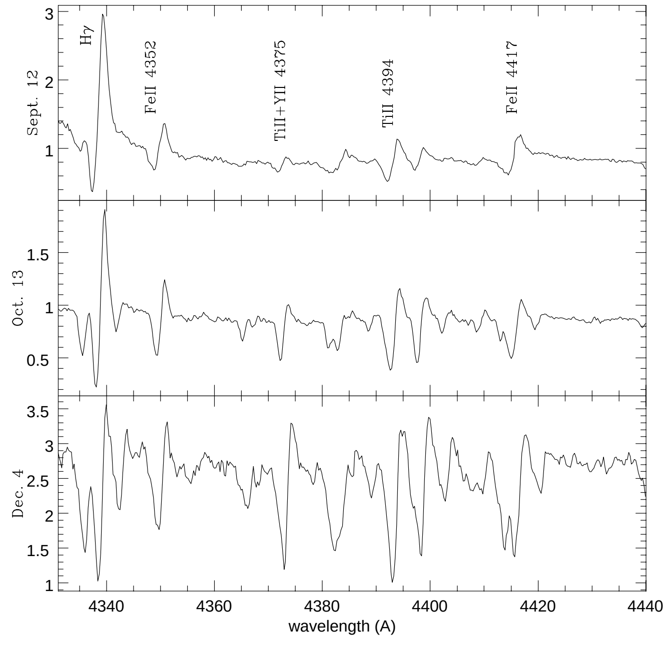

Fig. 11. Tracings of high dispersion spectra of V723 Cas in Hγ region

There is one unidentified absorption line at 449.5 nm, the equivalent width of which was 0.15 Å on September 12 and 0.06 Å on December 4 (Table 5). Its laboratory wavelength may be 449.71±0.02 nm.

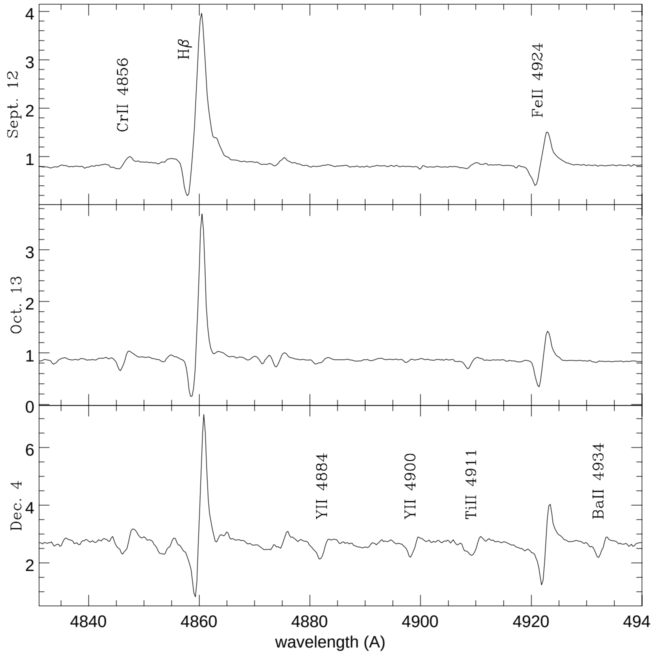

Fig. 12. Tracings of high dispersion spectra of V723 Cas in Hβ region

6. Distance to the nova and absolute magnitude at maximum

Using the doublet-ratio method (Münch 1968) for the Na I D1 and D2 lines (Fig. 5 of Münch), we have a column density of Na I atoms to the nova:

$$\log\left(\mathrm{N(Na\,I)\cdot d}\right) = 13.26\ \mathrm{cm}^{-2} \quad (1)$$

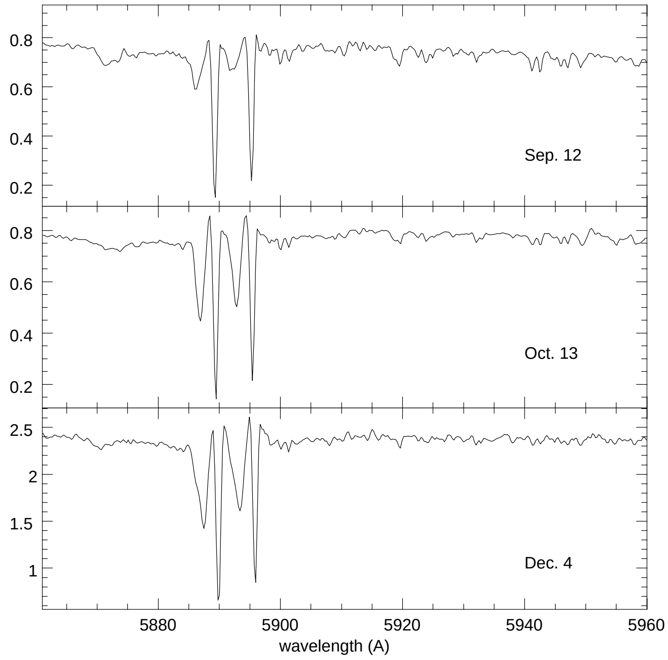

Fig. 13. Tracings of high dispersion spectra of V723 Cas in Na I D1 and D2 region

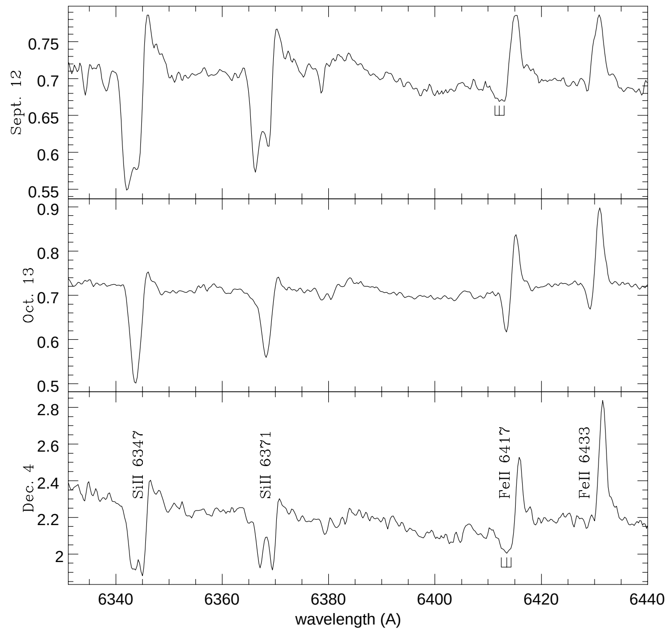

Fig. 14. Tracings of high dispersion spectra of V723 Cas in Si II 6347 and 6371 region. The multiple absorption components of Fe II at 641.7 nm are indicated by lines

from the equivalent widths of the interstellar components of Na I D1 and D2 lines, where N(Na I) is the space density of Na I atoms and ‘d’ is the distance. If we assume the space density of Na I atoms as $2{\times}10^{-9}$ cm^{-3} (Münch 1968), the distance to the nova should be 2.95 kpc. It is difficult to evaluate the error in the distance, because there is large uncertainty in the space density of Na I atoms (see, e.g. Binnendijk 1952). The data presented in Table 5 of Binnendijk (1952) show that the mean error in the distances derived from the equivalent widths of interstellar Na I D1 and D2 lines of the objects in the Perseus region may have been about $\pm 25\%$. Therefore, here we adopt a probable error ± 0.7 kpc in the distance to the nova.

A well studied open cluster NGC 457 locates within an angular distance of 4.7° from the present nova. Pesch (1959) estimated the distance to the cluster as 2.88 ± 0.58 kpc and the interstellar reddening as $\mathrm{E(B-V)} = 0.46$. Some members of the cluster have had higher reddenings such as $\mathrm{E(B-V)} = 0.48 \sim 0.54$ (Pesch 1959), but the higher ones may have been due to the interstellar matter in the own cluster.

An approximate formula for the distribution of interstellar extinction in our galaxy was proposed by Parenago (1948) :

$$\mathrm{A_V} = \frac{\mathrm{a\,c}}{\sin|\mathrm{b}|}\left(1 - \exp(-\frac{\mathrm{d}\,\sin|\mathrm{b}|}{\mathrm{c}})\right) \qquad (2)$$

where ‘a’ is an amount of extinction in magnitude per kpc, ‘b’ is the galactic latitude, c= 0.15 kpc is a scale height, and ‘d’ is distance in kpc. Since the galactic latitude of NGC 457 is $-4.35°$, the amount of the extinction in this direction may be about 0.94 mag kpc^{-1}. Using the same amount of extinction, we have an interstellar extinction to the nova ($\mathrm{b} = -8.8°$, d=2.95 kpc) as $\mathrm{A_V} = 0.88$ mag. The interstellar extinction in the area No. 17 ($\mathrm{l} = 128°,\ \mathrm{b} = -3°$) of Neckel and Klare (1980) is about $\mathrm{A_V} = 1.8$ mag. at 3 kpc. After the same process we have a=0.97 $\mathrm{mag\ kpc^{-1}}$ in this area and $\mathrm{A_V} = 0.90$ mag. for the nova, which agree with those derived from the data of NGC 457. Here we adopt $\mathrm{A_V} = 0.89$ mag. for the nova. The absolute magnitude at the light maximum may be $\mathrm{M_V(max)} = -6.1 \pm 0.5$, where $\mathrm{m_V(max)} = 7.1$ (Fig. 1). This absolute magnitude is not rare among slow classical novae at maxima (see, e.g. Payne-Gaposchkin 1957; van den Bergh & Younger 1987).

The UBV photometric data supplied by V. Goranskij (Fig. 1), show that the light maximum in the B band occurred on 1995 December 17 by $\mathrm{m_B(max)} = 7.6$. The absolute B magnitude at the maximum may have been about $\mathrm{M_B(max)} = -5.9 \pm 0.5$. Using the Eq. (6) of Livio (1992), we have a mass of the white dwarf as $0.58{\pm}0.07\,\mathrm{M_\odot}$. This value is close to the lower limit of the mass of a white dwarf which performs nova’s explosion (Kovetz & Prialnik 1985).

7. Radial velocity

Fig. 15 shows mean radial velocities of absorption and emission components of Fe II lines. Solid squares indicate radial velocities of the absorption components measured on the high dispersion spectra and open squares indicate those of the emission components (Table 3). The observational error is smaller than the symbols. The mean radial velocities of absorption components measured on the medium dispersion spectra (Table 2) are given by triangles with error bar.

When the emission components were strong in the early stage, the absorption components on the medium dispersion spectra had systematically larger negative radial velocities with

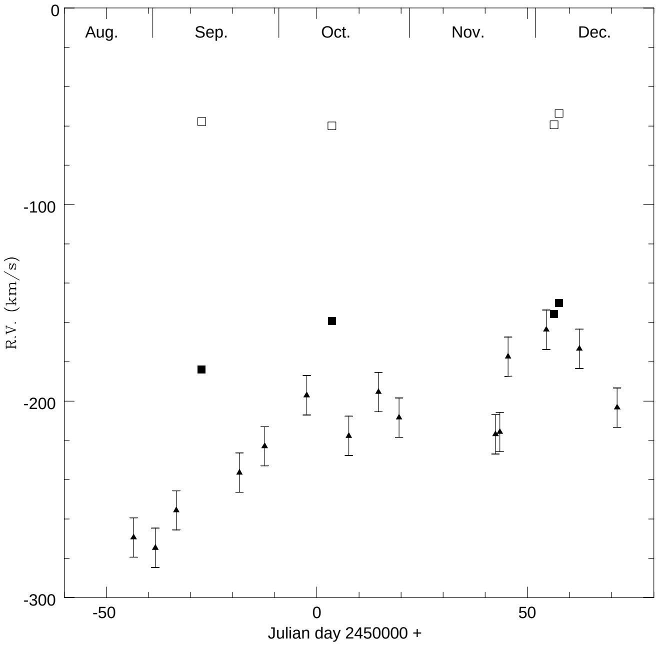

Fig. 15. Mean radial velocities of Fe II lines. Open squares show radial velocities of emission component measured on the high dispersion spectra, while solid squares are of absorption component. Triangles with error bar indicate those of absorption component measured on the medium dispersion spectra

respect to those of the high dispersion spectra. Because of the lower spectral resolution, the red side of the absorptions may have been filled by the emission components. The values measured on the medium dispersion spectra in the early stage, therefore, may not have represented the real velocity of absorptions. The radial velocity of the absorption components in the earliest stage may have been roughly -220 km s^{-1}, which was estimated by an extrapolation from the results measured on the high dispersion spectra. The emission components were nearly stable at -57.7 km s^{-1}. The blue-shift of the absorption components with respect to the emission components may have been about -160 km s^{-1} in the earliest stage. The same quantity was -126 km s^{-1} in September and -96 km s^{-1} in December. Such low velocities are fairly unusual among classical novae. For example, even in the slowest classical nova HR Del, the absorption components of H I and metallic lines were blue-shifted by about $-600 \sim -700$ km s^{-1} in the early stage and about -200 km s^{-1} at the end of pre-maximum stage (Hutchings 1971). Only RR Pic had a still lower blue-shift (-72 km s^{-1}) of absorption components in the pre-maximum stage (Lunt 1926; Table 10.2 of Payne-Gaposchkin 1957).

The blue-shift of the absorption components decreased with time during the pre-maximum stage (Fig. 15) like as other novae. On the light maximum, however, the blue-shift slightly increased. Probably a new high velocity absorption system emerged on the light maximum.

8. Concluding remarks

Since the spectral evolution of this nova after the light maximum has been very similar to that exhibited by normal classical novae (Iijima & Rosino 1996; 1997, and a detailed report will be made in a forthcoming paper), this object may not be classified in the group of symbiotic novae such as RT Ser, RR Tel, PU Vul etc., even if the evolution was very slow. It seems that RR Pic, HR Del and the present nova construct a group of rare classical novae characterized by slowest evolution.

Friedjung (1992) analysed the properties of HR Del in detail and suggested that the very slow explosion may have occurred under a critical condition. A recent theoretical work by Kato and Hachisu (1994) showed that extremely slow explosions may occur on a white dwarf with a mass of less than 0.6 $M_\odot$. The derived mass $0.58\pm0.07\,M_\odot$ of the white dwarf in this system seems to be consistent with that expected from their model. Kovetz and Prialnik (1985) suggested that the explosion on such a low mass white dwarf could occur only under a very restricted condition. Detailed studies about this nova are required to advance our knowledge about the critical condition of novae's explosions.

Acknowledgements. I am grateful to Dr. Stig Linander, Dr. V. Goranskij, and the members of VSOLJ who supplied the photometric data of V723 Cas on the VSNET.

References

Binnendijk L., 1952, ApJ 115, 428
Friedjung M., 1992, A&A 262, 487
Hutchings J.B., 1971, Publ. Dom. Astrophys. Obs. 13, 347
Iijima T., Rosino L., 1996, IAU Circ. 6365
Iijima T., Rosino L., 1997, IAU Circ. 6703
Kato M., Hachisu I., 1994, ApJ 437, 802
Kovetz A. Prialnik D., 1985, ApJ 291, 812
Livio M., 1992, ApJ 393, 516
Lunt J., 1926, MNRAS 86, 498
Munari U., Goranskij V.P., Popova A.A., etc., 1996, A&A 315, 166
Münch G., 1968, in "Nebulae and Interstellar Matter", eds. B.M. Middlehurst, L.H. Aller, The University of Chicago Press, Chicago, p. 388
Neckel Th., Klare G., 1980, A&AS 42, 251
Ohsima O., Akazawa H., Ohkura N., 1996, IBVS 4295
Parenago P.P., 1948, Uspekhi Astro. Nauk. 4, 69
Payne-Gaposchkin C., in "The Galactic Novae", North-Holland Publ. Co., Amsterdam
Pesch P., 1959, ApJ 130, 764
Rafanelli P., Rosino L., 1978, A&AS 31, 337
Sanyal A., 1974, ApJS 28, 115
Spencer Jones H., 1931, MNRAS 91, 777
van den Bergh S., Younger P.F., 1987, A&AS 70, 125
Williams G.V., 1995, IAU Circ. 6213
Yamashita Y., 1975, Ann. Tokyo Astron. Obs. 15, 1