Spectral Evolution of the Unusual Slow Nova V5558 Sagittarii

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Abstract

We report on the spectral evolution of the enigmatic, very slow nova V5558 Sgr, based on low-resolution spectra obtained at the Fujii-Bisei Observatory and the Bisei Astronomical Observatory, Japan during the period of 2007 April 6 to 2008 May 3. V5558 Sgr shows a pre-maximum halt, and then several flare-like rebrightenings, which is similar to another very slow nova, V723 Cas. In our observations, the spectral type of V5558 Sgr evolved from the He/N type toward the Fe II type during a pre-maximum halt, and then toward the He/N type again. This course of spectral transition was observed for the first time in the long history of nova research. In the rebrightening stage after the initial brightness maximum, we could identify many emission lines accompanied by a stronger absorption component of the P Cyg profile at the brightness maxima. We found that the velocity of the P Cyg absorption component, measured from the emission peak, decreased at the brightness maxima. Furthermore, we compared the spectra of V5558 Sgr with V723 Cas, and other novae that exhibited several rebrightenings during the early phase.

Key words: novae, cataclysmic variables — stars: individual (V5558 Sagittarii)

1. Introduction

Novae are a kind of cataclysmic variable stars, i.e., close binary systems consisting of a white dwarf and a low-mass normal star (for a review, see Hellier 2001). The cause of the nova eruption is considered to be a thermonuclear runaway reaction on the surface of the white dwarf. Matter transferred from the secondary is accumulated and compressed on the white dwarf. When the temperature and density increase sufficiently, thermo-nuclear runaway reactions occur, which cause nova eruption (Prialnik 1986).

A nova eruption is a very exciting phenomenon, and the nova systems are the best classically known transient objects. Payne-Gaposchkin (1964) classified the nova light curve based on the time in days for a decline by 2 magnitudes from the maximum, $t_2$. Duerbeck (1981) reported that there are some light-curve types of novae. They suggested a classification system for nova light curves including a class that shows a dust dip. Besides these classifications based on the light curve, McLaughlin (1942, 1944) introduced various classes of spectral evolution (see also Payne-Gaposchkin 1957). Williams (1992) divided the early post-outburst spectra of novae into two classes, the Fe II-type nova and He/N-type nova, based on the emission lines. They proposed that the Fe II-type spectrum is formed in a continuous wind, while the He/N-type spectrum is formed in a discrete shell. They also suggested the physics of the hybrid nova, showing the transition from the Fe II to the He/N spectrum, or simultaneous emission lines of both types. The diversity of light curves and spectral evolutions of the novae [demonstrated by e.g., Kiyo et al. (2004) and Strope et al. (2010)], however, has not been fully understood. Recently, Strope et al. (2010) reported the classification and properties of the nova light curves. They noted that there are at least 14 novae showing rebrightenings during the early phase, like V5558 Sgr, and that some of these novae are not very slow, in 93 novae of their sample.

V5558 Sgr was discovered by Y. Sakurai at 2007 April 14.777 (UT) at magnitude 10.3. Sakurai gave the position for the new object as RA $= 18^h 10^m 18^s 4$, Dec $= -18^\circ 46' 51''$ (see Nakano et al. 2007). In addition, Sakurai reported that nothing was visible at this location at April 9.8 (limiting magnitude 11.4). K. Haseda located several prediscovery images of V5558 Sgr, providing the following estimated magnitudes: 11.8, 11.2, 10.8, and 10.4 mag at April 7.780 (UT), 11.792, 13.793, and 14.777, respectively (data taken from CBET 931) (Nakano et al. 2007). Iijima (2007) obtained medium-dispersion spectra at April 20.12 and 20.14 (UT). In their observations, there are Balmer, He I, Fe II, Mg II, Si II, and probably N II lines in emission. The full widths at half maximum (FWHMs) of H$\beta$ and He I are 480 km s$^{-1}$ and 360 km s$^{-1}$, respectively. Moreover, most of the prominent emission lines are accompanied by weak absorption components of the P Cyg profiles, blueshifted by 400–500 km s$^{-1}$.

Poggiani (2008a) reported the spectroscopic monitoring of V5558 Sgr during the pre-maximum stage, and the early decline, and found that there are Balmer and Fe II lines in emission during the pre-maximum stage. The spectra after the first maximum showed Balmer, Fe II, and He I emission lines. Poggiani (2008a) pointed out that the spectroscopic evolution is similar to that of the slow nova V723 Cas.
Table 1. Spectroscopic observations of classical nova V5558 Sgr.

| Date       | Spectral range (Å) | JD (2454000+) | Comments                     |
|------------|--------------------|---------------|------------------------------|
| 2007 April 16 | 3800–8300         | 207.27        |                              |
| April 25   | 3800–8300         | 216.27        |                              |
| May 2      | 3800–8200         | 223.27        |                              |
| May 8      | 3800–8200         | 229.27        |                              |
| May 25     | 3800–8300         | 246.18        |                              |
| June 10    | 3800–8200         | 262.16        |                              |
| July 11    | 3800–8200         | 293.07        | at the initial maximum       |
| July 23    | 3800–8300         | 305.03        | after the initial maximum    |
| July 27    | 3800–8200         | 309.00        | around the second mini-maximum|
| July 30    | 3800–8300         | 312.00        | around the second mini-maximum|
| August 9   | 3800–8300         | 321.99        | around the second mini-maximum|
| August 12  | 3800–8300         | 325.02        | at the third maximum         |
| August 15  | 3800–8200         | 327.98        |                              |
| August 16  | 3800–8200         | 329.06        |                              |
| August 25  | 3800–8300         | 337.97        |                              |
| September 5 | 3800–8300       | 348.97        |                              |
| September 12 | 3800–8200     | 355.95        |                              |
| September 25 | 4600–6700     | 368.91        | at the fourth maximum        |
| October 6  | 4600–6700         | 379.91        |                              |
| October 23 | 4600–6700         | 396.86        | at the fifth maximum         |
| November 2 | 4600–6700         | 406.92        | declining from the fifth maximum|
| November 7 | 4600–6700         | 411.90        |                              |
| November 11 | 4600–6700    | 415.89        |                              |
| November 23 | 4600–6700     | 427.88        |                              |
| 2008 February 12 | 3900–8300 | 509.37        |                              |
| February 27 | 3900–8400        | 524.34        |                              |
| March 8    | 3900–8400         | 534.35        |                              |
| March 17   | 3900–8400         | 543.32        |                              |
| March 31   | 3900–8400         | 557.31        |                              |
| April 14   | 3900–8400         | 571.28        |                              |
| April 24   | 3900–8300         | 581.28        |                              |
| May 3      | 3900–8300         | 590.26        |                              |

Furthermore, Poggiani (2010) reported the spectroscopic follow-up during the decline stage. They derived the absolute magnitude of $-6.3$ to $-5.9$, the typical magnitude at maximum for slow novae, such as V723 Cas and HR Del. They also estimated the distance of $1.3$–$1.6$ kpc and a white-dwarf mass of $0.58$–$0.63 M_\odot$. Poggiani (2010) mentioned that the low white-dwarf mass suggested that V5558 Sgr is a critical system whose mass is close to the lower limit to trigger the nova outburst.

Our spectral observations are summarized in section 2. The results of the spectral monitoring of V5558 Sgr are described in section 3. We discuss the properties in the light curves and the spectral evolutions in section 4. Conclusions are stated in section 5.

2. Observation

Our low-dispersion spectra with a resolution of $\lambda/\Delta\lambda \approx 600$ (at 5852 Å) were taken with the FBSPEC1 and FBSPEC2, which were developed by one of the authors (MF), attached to the 28 cm telescope of the Fujii-Bisei Observatory (Okayama, Japan). The spectral coverage is 3800 to 8400 Å. The spectra were obtained on 32 nights when the targets were brighter than $V = 10–11$ mag. The signal-to-noise ratios were typically 10 to 30. Reduction of the spectra was carried out with NOAO IRAF in the standard way, and a flux calibration was performed using a local spectrophotometric standard star. Table 1 gives the journal of our spectroscopic observations.

3. Results

Figure 1 shows the light curve of V5558 Sgr, collected from the archive of VSNET (Kato et al. 2004), AAVSO,1 ASAS-3 (Pojmanski 2002), and Pi of the Sky archives.2 The brightness slowly rises for about two months before the initial brightness maximum. This flat phase is known as the pre-maximum halt. It is known that the duration of the pre-maximum halt depends on the decline speed of the nova (see Bode & Evans

1 (http://www.aavso.org/).
2 (http://grb.fuw.edu.pl/pi/).
In slow novae, the duration is typically several days. The duration of the pre-maximum halt is, however, at least 60 days in V5558 Sgr, which is much longer than the typical duration. After the first maximum, the light curve shows several rebrightenings superposed on a flat part that lasts about four months until JD 2454405. The pre-maximum halt and repetitive outbursts were also observed in V723 Cas, V1548 Aql, HR Del, and DO Aql (see e.g., V723 Cas: Ohsima et al. 1996; Munari et al. 1996; Iijima et al. 1998; V1548 Aql: Kato & Takamizawa 2001; HR Del: Terzan 1970; DO Aql: Vogt 1928). After the rebrightenings, V5558 Sgr decayed slowly and smoothly, though there were small fluctuations. In this section, we present the spectra of V5558 Sgr in our observations during the three stages: the pre-maximum stage, the rebrightening stage, and the decline stage after the rebrightening stage.

3.1. The Pre-Maximum Stage

Figure 2 shows the spectra of V5558 Sgr during the pre-maximum stage. In this stage, we obtained the spectra on 6 nights between 2007 April 16 and 2007 June 10 (JD 2454202.27–2454262.16). The first observation was carried out on 2007 April 16 (JD 2454202.27), two days after the discovery. This spectrum shows the presence of emission lines of Balmer, He I, N II, Si II, Fe II, Ca I, and [O I], but is dominated by the strong Balmer and He I lines. These emission lines exhibited sharp profiles, unlike the typical flat-topped profiles of He/N novae. The FWHMs of these emission lines are about 500–700 km s\(^{-1}\), which are almost equal to the typical value of Fe II type novae, not He/N novae.

On April 25 (JD 2454216.27), He I lines became weaker compared to the previous spectrum, while some Fe II lines appeared in emission. Moreover, the emission line of Si II disappeared, and the absorption lines of Si II 6347 and 6371 appeared instead. These Si II absorption lines are also seen in the pre-maximum spectra of V723 Cas. In the next 4 spectra between May 2 and June 10 (JD 2454223.27–2454262.16), there were strong Balmer and Fe II lines. In addition, there were also weak C I, C II, O I, and [Fe II] lines in emission, and the absorption lines of Si II. The red part of these spectra shows absorption lines, due to atmosphere absorption.

3.2. The Rebrightenings Stage

Next, we present the spectra during the rebrightening stage. On 2007 July 11 (JD 2454293.07), just at the initial maximum, the spectrum had remarkably changed (figure 3). There are Balmer and Fe II lines in emission with an absorption component of the P Cyg profile. All of the spectra between July 23 and August 16 are presented in figure 4. On July 23 (JD 2454305.03), after the initial maximum brightness,
there were many emission lines of Balmer, Fe II, He I, O I, Ni II, C II, Cr II, and [Fe II]. In the next three observations (JD 2454309.00–2454321.99), at the second mini outburst and before the third maximum brightness, presented in figure 4, the spectra do not show any distinct change compared to the previous spectrum regarding identified lines.

The next spectrum was obtained on August 12 (JD 2454325.02), at the third maximum. We can identify the Balmer series, Fe II, O I, [O I], Ni II, C II, and He I lines. In the Balmer series and Fe II lines, we can identify strong P Cyg profiles. Moreover, the continuum is stronger than the previous spectrum. The spectra on August 15 and 16 (JD 2454327.98 and 2454329.06) were very similar to the previous spectrum regarding identified lines, though the absorption component of the P Cyg profile became weak and He I lines became strong.

During the plateau phase between the third and fourth brightness maxima, we observed this object on 3 nights (JD 2454337.97–2454355.95) (figure 5). There were Balmer, Fe II, O I, He I, Ni II, C II, and [Fe II] lines in emission on all of the 3 nights, and the absorption component of the P Cyg profile appeared in He I 5876. In addition, on September 12 (JD 2454355.95), we could identify [N II] 5755.

On September 25 (JD 2454368.91), just at the fourth maximum, the spectrum had obviously changed; the continuum became strong, and the P Cyg profile reappeared in Balmer and Fe II lines. After the peak, V5558 Sgr rapidly decayed. On October 6 and 23 (JD 2454379.91 and 2454396.86), we could also identify P Cyg profiles in the Balmer and Fe II lines. He I 5876 became strong and is accompanied by an absorption component of the P Cyg profile. There were also [N II] and [O I] lines.

The spectra during the later phase of the rebrightening stage were obtained on 13 nights between 2007 November 28 and 2008 January 29 (figure 6). On November 2 (JD 2454406.92), there were Balmer series, Fe II, He I, O I, [O I], Ni II, [N II], and C II lines in emission. P Cyg profiles appeared in Balmer and Fe II lines, in addition to He I line. In the next 3 spectra, on November 7, 11, and 22 (JD 2454411.90–2454427.88), we could identify similar characteristics in emission. The absorption components of P Cyg profiles decayed little by little.

### 3.3. The Decline Stage after the Rebrightening Stage

After the fifth maximum, the light curve declined smoothly. V5558 Sgr was, however, unobservable between 2007 November 28 and 2008 January 29, due to the solar conjunction. In this subsection, we present spectra obtained after this non-observation phase. All of the spectra during the decline stage are presented in figure 7. In this stage, the intensities of the He I lines increased, compared to the previous stage. On February 12 (JD 2454509.37), there were Balmer, He I, Ni II, Fe II, He II, [N II], [O I], O I, C II, and Si II lines in emission. We could classify this nova as a hybrid nova, which evolved from the Fe II nova toward the He/N nova. Note that He I lines were dominant on 2007 April 16 (JD 2454202.27). On February 27 (JD 2454524.34), the main features were same as on the previous day, but the spectrum showed O I 7454 and Si II 5800 lines in emission, and a disappearance of the N II 5680 and N II 5961 lines. On March 8 (JD 2454534.35), there were Si II or C I lines (5041 Å) in emission. On May 3 (JD 2454590.26), the intensity of He II 4686 increased, compared to the previous spectrum. There were Cr II or additional Fe II lines (6082 Å or 6084 Å, respectively) in emission.
Fig. 4. Representative spectral evolution of V5558 Sgr during the early rebrightening stage from 2007 July 23 to August 16. For visuality, the data after July 27 are vertically shifted.

Fig. 5. Representative spectral evolution of V5558 Sgr during the mid-rebrightening stage from 2007 August 25 to October 6. For visuality, the data after September 5 are vertically shifted.

Fig. 6. Representative spectral evolution of V5558 Sgr during the late rebrightening stage from 2007 October 23 to November 23. For visuality, the data after November 2 are vertically shifted.
4. Discussion

4.1. Behavior during the Pre-Maximum Stage and Comparison with Pre-Maximum Halts of Other Novae

The light curve of V5558 Sgr shows a prominent premaximum halt, lasting for at least 60 days. Although the origin of the pre-maximum halt is not yet clear, it is known that the duration depends on the speed class. This long duration is also seen in some slow novae, V723 Cas, V1548 Aql, HR Del, and V463 Sct, known to be the very slow novae, except V463 Sct. The evolution of the light curve of V5558 Sgr is similar to that of, especially, V723 Cas in that they both show a long pre-maximum halt, several rebrightenings on a flat part and a slow decline. V5558 Sgr is also classified as a very slow nova. This is compatible with the feature of the long pre-maximum halt and subsequent flare-like maxima.

Friedjung (1992) referred to spectroscopic observations of HR Del during the pre-maximum stage (cf. Hutchings 1970). They mentioned that the expansion velocity of the photosphere is very low (200 km s\(^{-1}\)), unlike the majority of classical novae. They suggested that the conditions of thermonuclear runaway were only marginally satisfied in HR Del. This interpretation is consistent with the derived white-dwarf mass in HR Del (0.52 \(M_\odot\); Bruch 1982; 0.595 \(M_\odot\); Kuerster & Barwig 1988) according to models of thermonuclear runaways (see Prialnik & Kovetz 1995). This suggestion may, thus, apply to similar slow nova, V5558 Sgr. It is important to measure the white-dwarf mass of V5558 Sgr. Note that Orio and Shaviv (1993) suggested another hypothesis, a local thermonuclear runaway, for the pre-maximum halt.

Kato et al. (2002) advocated that V463 Sct provided a unique opportunity for testing the interpretation of pre-maximum halts, which requires that the conditions of thermonuclear runaway were only marginally satisfied. Hachisu and Kato (2004) presented an interpretation of long maximum halts from the theoretical side. They estimated the WD masses to be 0.59 \(M_\odot\) for V723 Cas and 1.1 \(M_\odot\) for V463 Sct by fitting the decline rate of reproduced light curves, excluding the brightness maxima, based on the optically thick wind model. They concluded that a nova attains its maximum brightness in optical light, and has a flat peak when the envelope mass is massive enough and the temperature of white dwarf surface decreases to below \(\sim\)7000 K. The duration of the flat peak is considered to depend on the initial envelope mass at ignition (Hachisu & Kato 2004). This flat peak can be regarded as a pre-maximum halt. They interpreted several strong peaks of the light curve of V723 Cas as pulsations of the nova envelope, as discussed by Schenker (1999). He attempted to apply radial pulsations, based on the \(\kappa\)-mechanism, in envelopes to the physical origin of the oscillation phase of classical novae. In V5558 Sgr, the brightness during the pre-maximum halt slowly rise unlike V723 Cas. This feature is not explained by the scenario proposed by Hachisu and Kato (2004).

Iijima et al. (1998) presented the spectral evolution of V723 Cas. They reported the spectra in the long pre-maximum stage. There were Balmer and Fe II lines in emission. Most of the emission lines were accompanied by strong absorption components of the P Cyg profiles. The emission lines gradually weakened, and the absorption lines developed. These features of the emission and absorption lines were not seen in our observations of V5558 Sgr. In our observations, there were also Balmer and Fe II lines in emission. The emission lines, however, did not weaken, and strong absorption components of the P Cyg profiles did not appear during the pre-maximum stage. On April 16 (JD 2454202.27), we can identify the absorption component of the P Cyg profile of HeI 6678 with the blue-shift velocity, about \(-500\) km s\(^{-1}\). This value is higher than the velocities in V723 Cas, by about \(-100\) km s\(^{-1}\) or in HR Del, by about \(-200\) km s\(^{-1}\) (see Iijima 2006; Friedjung 1992). Moreover, Iijima et al. (1998) reported that the blue-shift of the absorption components decreased with time during the pre-maximum stage and then slightly increased at the maximum brightness. They suggested that this is because a new high-velocity absorption system emerged. We can not confirm this trend in V5558 Sgr, since the absorption components of the P Cyg profiles disappeared during the pre-maximum stage. A detailed description of the spectral evolution is given in subsection 4.3. The difference of V5558 Sgr with V723 Cas and HR Del suggests a possibility that V5558 Sgr had the heavier white dwarf and the ejecta of...
V5558 Sgr was lighter, and a specific photosphere could not form during the pre-maximum phase, then.

4.2. Blue-Shift Velocities of the Absorption Components of the P Cyg Profiles

Table 2 gives the blue-shift velocities of the absorption components of the P Cyg profiles. We hereafter call the velocity of the absorption component measured from the emission peak as the radial velocity for simplicity. In the pre-maximum stage, the radial velocities of the He I, Fe II, and H I lines are about $-500$ to $-700$ km s$^{-1}$. After the initial brightness maximum, the radial velocities increase. In the rebrightening stage, the radial velocities become higher, over about $-1000$ km s$^{-1}$. We can find the trend that the radial velocity becomes low at the brightness maximum, and becomes high outside the brightness maximum. After the rebrightening stage, the absorption components disappear, and we could not derive the radial velocity, except on 2008 March 17. The radial velocity of He I 5876 on March 17 is higher, $-1760$ km s$^{-1}$. The long-term trend of increase of the radial velocity suggests that the velocity was higher in the inner region because the photosphere gradually shrank. This suggestion is consistent with the low radial velocity at the brightness maximum when re-expansion of the photosphere occurred, as noted in subsection 4.4.

4.3. Spectral Type of V5558 Sgr

The spectral evolution of V5558 Sgr is very rare. On 2007 April 16 (JD 2454202.27), during a pre-maximum halt, the spectrum of V5558 Sgr was dominated by Balmer and He I lines in emission. These emission lines of the spectrum showed the nature of the He/N type nova. The FWHMs of H$\alpha$ and He I 5876 Å were, however, of low velocities, about 700 km s$^{-1}$ and 500 km s$^{-1}$, respectively, unlike in the majority of He/N novae. The He I lines then weakened very much by April 25, and Fe II lines appeared. Williams (1992) reported the existence of hybrid-type nova. They suggested that Fe II spectra, in the transition from the Fe II to the He/N spectrum, with unusually broad lines, the half width at zero intensity (HWZI) > 2500 km s$^{-1}$, probably originated from discrete shells that were rather massive, and therefore optically thick. As the expanding shell became optically thin, the spectrum changed to the more typical higher ionization He/N spectrum of the shells. This scenario may not apply to the pre-maximum stage. The spectrum during the pre-maximum halt of slow novae is basically dominated by Fe II type emission lines (see figure 2 in this paper and Iijima et al. 1998). The spectrum at the earliest phase during the pre-maximum halt may also show emission lines of the He/N type also in other novae. The earliest spectrum may have been overlooked in other novae, since the duration of this stage should be very short. The spectral transition of V5558 Sgr during the early stage, from the He/N type toward the Fe II type, was a rare evolution, at least at this time. Moreover, the spectra of V5558 Sgr then evolved to the Fe II and He/N hybrid type after the initial maximum brightness (for example, the spectrum on 2007 July 23). We note that the He I lines became weak and P Cyg absorptions became strong at the maximum brightness. Furthermore, the He I and He II lines became strong at the decline stage after the rebrightening stage. The FWHMs of He I or Balmer at the decline stage were about 800–900 km s$^{-1}$, which is slower than the typical He/N novae.

As noted in the subsection 4.1, Iijima et al. (1998) presented the spectral evolution of V723 Cas. They reported the spectra in the long pre-maximum stage. There were Balmer and Fe II lines in emission. Most of the emission lines were accompanied by strong absorption components of the P Cyg profiles. Iijima (2006) reported on the spectral evolution after the maximum brightness of V723 Cas. In V723 Cas, two weeks after its maximum and at about two magnitudes below its maximum, there were Balmer, Fe II, and He I emission lines.
simultaneously. At the second brightening, P Cyg absorption components appeared on Balmer, He I, and Fe II lines. When the nova faded by about four magnitudes, during the decline stage, the prominent emission lines were of Balmer, He I, [N II], [Fe II], [O III], N II, N III, and Si II, while most of the emission lines of Fe II had disappeared. This transition after the initial maximum brightness of V723 Cas is similar to that of V5558 Sgr. The transition during the pre-maximum stage are, however, different between V5558 Sgr, He/N type toward Fe II type, and V723 Cas. It should be noted that V723 Cas possibly showed the He/N spectra before the first observation by Iijima et al. (1998).

4.4. Comparison with the Rebrightening Novae during the Early Phase

The light curves of some novae, for example V1186 Sco, V2540 Oph, V5113 Sgr, V4745 Sgr, and V458 Vul, show several rebrightenings during the early phase (see e.g., V1186 Sco: Schwarz et al. 2007; V2540 Oph: Ak et al. 2005; V5113 Sgr: Kiyota et al. 2004; V4745 Sgr: Csák et al. 2005; V458 Vul: Poggiani 2008b). The spectra of these novae show many emission lines accompanied by the absorption components of P Cyg profiles at the brightness maximum (Tanaka et al. 2011). Tanaka et al. (2011) suggested that the reappearance of the absorption component at the rebrightening maxima is attributable to re-expansion of the photosphere after it once shifts sufficiently inside. The spectra of V5558 Sgr also show a similar trend; that the absorption components of the P Cyg profiles developed at the brightness maximum. The photosphere of V5558 Sgr could, thus, cause a similar physical transition. They also reported that the time interval between successive maxima gradually increased. We can not identify this trend for V5558 Sgr.

5. Conclusions

The light curve of V5558 Sgr shows a pre-maximum halt, and then several flare-like rebrightenings. V5558 Sgr is classified as a very slow nova, and is similar to V723 Cas. We obtained the low-resolution spectra of V5558 Sgr at the Fujii-Bisei Observatory on 32 nights between 2007 April 16 and 2008 May 3.

We have presented the behavior of the pre-maximum stage and compared it with other novae. The transition of spectra of V5558 Sgr is roughly similar to the very slow nova V723 Cas. The transition from He/N type to Fe II type during the pre-maximum stage, however, seems to be a unique phenomenon in V5558 Sgr, though there is a possibility that this transition also occurs in other novae, but have been missed, since it occurs well before the maximum.

We found the trend that the radial velocity of the blueshift absorption component from the emission peak gradually increases, but becomes low at the brightness maximum.

Our data revealed spectroscopic changes during the pre-maximum halt, and then several flare-like rebrightenings. The spectra at the pre-maximum halt shows rare evolution. There were Balmer and He I lines at the first observation (JD 2454202.27), and then the spectra varied from the He/N nova to the Fe II type nova. The spectra at and around the brightness maximum during the rebrightenings can be identified by many lines accompanied by a strong absorption component of the P Cyg profile. There are also He I and Fe II lines simultaneously. Moreover, the He I and He II lines become strong during the decline stage. The FWHMs of emission lines are, however, lower than that of typical He/N novae.

In addition, we compared V5558 Sgr with other novae showing the several rebrightenings during the early phase. There are common features that the absorption components of the P Cyg profiles become strong at the maximum brightness. There is a possibility that the photosphere reexpanded at the maximum brightness.

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