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Line Evolution of the Nova V5587 Sgr from Early to Nebula Phase

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Abstract

The spectral evolution of the nova V5587 Sgr has been monitored at Koyama Astronomical Observatory and Higashi-Hiroshima Observatory, Japan, from the early to nebula phase. The nova rebrightened several times. The spectra during the early phase showed emission lines of Hα, Hβ, O I, He I, He II, N II, Fe II. Nova V5587 Sgr is classified into the Fe II type. The helium abundance of the nova is estimated as $N(\mathrm{He})/N(\mathrm{H}) = 0.134 \pm 0.09$. The light curve, the spectral evolution, and the helium abundance in V5587 Sgr are similar to those of the nova PW Vul.

Keywords: cataclysmic variables - classical novae - optical - spectroscopy - photometry - individual: V5587 Sgr.

1 Introduction

Photometric observations of novae are usually performed by many observers worldwide. The light curves of the novae have been revealed in detail, and they can be classified into several classes (Strope et al. 2010). In contrast, spectroscopic observations of novae are not performed as frequently as photometric observations because (i) the number of available spectrographs (and observers) are limited; (ii) some fraction of novae are too faint to observe by spectrographs in their later phase (or even at the maximum for some novae). As novae show a variety of spectral evolutions, spectroscopic monitoring can provide new insights into the physics and chemistry of novae. For example, recently Nagashima et al. (2013) detected molecular absorption bands of C_2 and CN in nova V2676 Oph. (This is the first detection of C_2 in novae and the second for CN.) This detection was performed as a part of long-term spectroscopic observations of this nova.

The light curves of novae in some classes (Strope et al. 2010) can be successfully reproduced by models (as reviewed by Prof. Kato at this meeting). However, the light curves in the "Jitter"and "Oscillation"classes (Strope et al. 2010) could not be reproduced well by the models. In this paper, we focus on the "Jitter"class and introduce our recent spectroscopic observations of V5587 Sgr classified in this class. We discuss the nature of this nova as it is likely that there are differrent types of oscillations (i.e., different physical conditions) of novae in the "Jitter"class. Different types of novae might

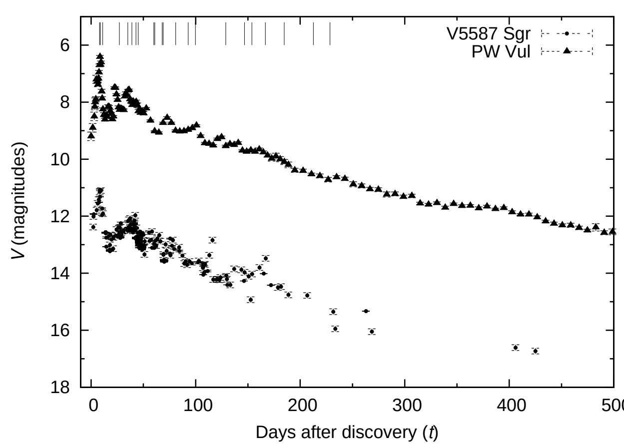

Figure 1: *V* band magnitudes of V5587 Sgr and PW Vul. The light curve of V5587 Sgr is from Higashi-Hiroshima Observatory, VSNET, and AAVSO observations. The light curve of PW Vul was refer to the online data of Strope et al.(2010).

be mixed together in this class. Even though there are high-quality photometric and spectroscopic observations for some Jitter class novae, the mechanism for their rebrightening is still unclear (Tanaka et al. 2011). By frequent spectroscopic observations, we can observe phenomena useful to reveal the physics of the nova. In order to investigate the mechanism for the rebrightening in the "Jitter" class novae, we have conducted spectroscopic observations of V5587 Sgr in 2011 − 2012.

The nova V5587 Sgr (= Nova Sgr 2011 No.1) was discovered on UT 2011 January 25.86 by Nishimura (Nakano et al. 2011). The first low-dispersion spectrum was obtained on UT 2011 January 28 at Koyama Astronomical Observatory. The spectrum shows prominent emission lines of Hα, Hβ and O I. These features suggest that this object is a classical nova (Arai 2011; Imamura 2011).

2 Observations

Our photometric and spectroscopic observations were performed at two sites. One site is Koyama Astronomical Observatory (Kyoto Sangyo University, Kyoto, Japan). We used the 1.3m Araki telescope with the LOSA/F2 spectrograph (Arai et al., in prep.) for low-dispersion spectroscopy. The wavelength coverage is 400 − 800 nm and the spectral resolving power is R = $\lambda/\Delta\lambda \sim 580$ at 600 nm. The other site is Higashi-Hiroshima Observatory (Hiroshima University, Hiroshima, Japan). We used the 1.5m Kanata telescope with TRISPEC (Triple Range Imager and SPECtrograph with polarimeter, shutdown in 2012) for photometry and with HOWPol (Hiroshima One-shot Wide-field Polarimeter) for spectroscopy. Its wavelength coverrage is 400 − 1000 nm, and spectral resolving power is R $\sim$ 400 at 600 nm.

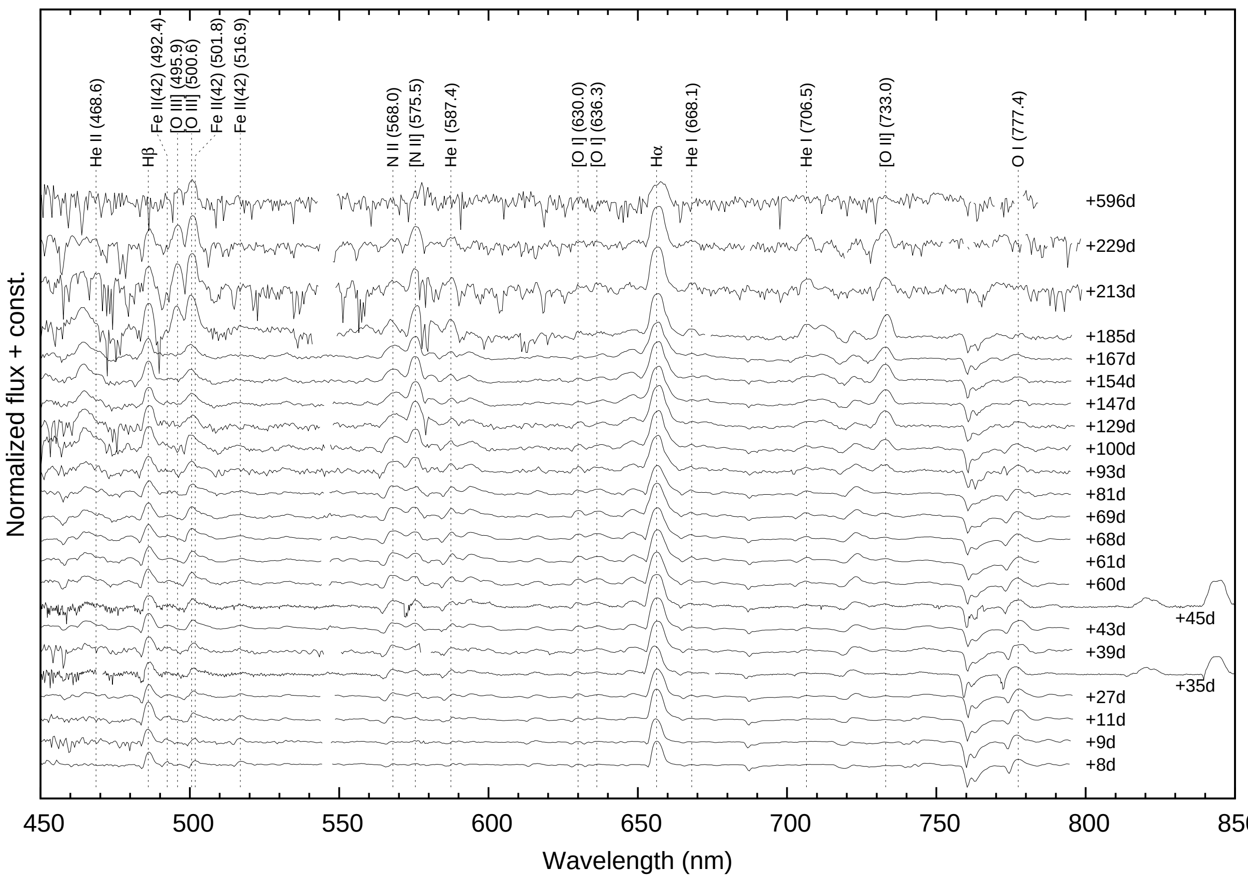

Figure 2: The normalized spectra of V5587 Sgr observed from +8d (= UT 2011 February 2) to +596d (= UT 2012 September 12) after the discovery. These spectra were obtained at Koyama Astronomical Observatory except for the data on +35d and +45d (= UT 2001 March 3 and 12), taken at Higashi-Hiroshima Observatory.

3 Results

Figure 1 shows light curves of V5587 Sgr. Since V5587 Sgr showed an erratic variation in the light curve, we consider that the nova is classified in the "Jitter" class. Particularly, V5587 Sgr seems to be a member of the sub-class prototyped by PW Vul as shown in Strope et al. (2010). Based on the light curves, we determined the date of the visual maximum as 9 days after discovery and also determined $t_2 = 12$ days and $t_3 = 108$ days. From $(B - V)$ at maximum magnitude and at t_2, we estimate the color excess by intersterllar extinction; $E(B - V) = 0.85 - 1.26$.

The light curve of V5587 Sgr is quite similar to that of the "Jitter" class nova PW Vul as shown Figure 1 (Schwarz et al. 1997, and references therein). PW Vul was discovered on 1984 July 27 (= JD 2445917) by Wakuda (Kosai 1984). This nova reached its maximum light of 6.3 magnitude in the V band on 1984 Aug 4th. We compare V5587 Sgr with PW Vul from various viewpoints in the next section.

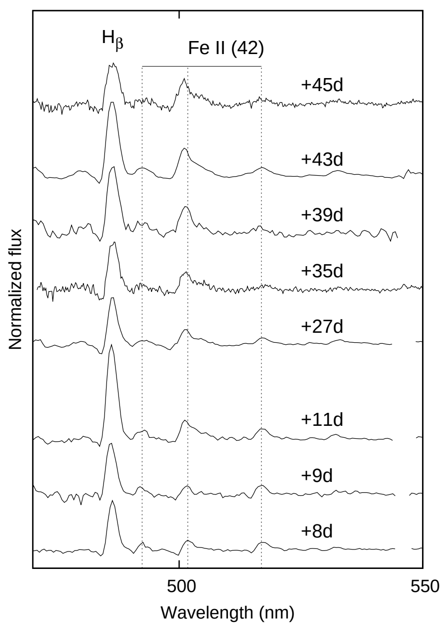

Figure 3: The spectra of V5587 Sgr in early phase. The nova never showed any regrowth of a P-Cygni profile.

Figure 2 shows the growth of Hα, Hβ, He I, He II, N II, [N II], O I, [O I], [O II], and Fe II emission lines of V5587 Sgr.

Novae that exhibit rebrightening in the early phase often show the regrowth of a P-Cygni profile (Tanaka et al. 2011, Csak et al. 2005) as in V4745 Sgr. However, V5587 Sgr has never shown this behavior (Figure 3).

It is considered that the nova entered into the nebula phase between July 11 to July 29 because the [O III] forbidden emission lines dominated Hβ at that time (Figure 4). We assume that the electron density in the nebula phase was $n_e = 10^6 \sim 10^8$ cm^{-3} according to Iijima & Esenoglu (2003) and Iijima (2006), and we estimate the helium abundance of the ejecta based on the data between July 11 and July 29 ; $N(\mathrm{He})/N(\mathrm{H}) = 0.134 \pm 0.09$ (for $n_e = 10^6$ cm^{-3}), $N(\mathrm{He})/N(\mathrm{H}) = 0.139 \pm 0.09$ (for $n_e = 10^8$ cm^{-3}).

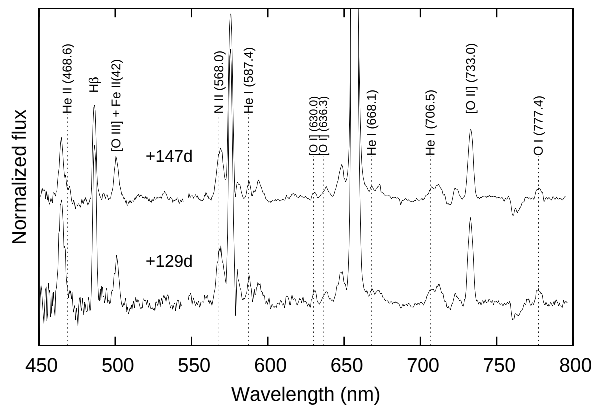

Figure 4: The spectra of V5587 Sgr in nebular phase(+129 days and +147 days after its maximum). An emission line of He II was recognized in these spectra.

4 Discussion & Conclusion

The decline rates, amplitudes, and intervals of rebrightening observed in V5587 Sgr are similar to those of PW Vul. This fact suggests that the WD mass and physical parameters related to the explosion of V5587 Sgr would be similar to those of PW Vul. Comparison between the spectra of V5587 Sgr and PW Vul also lead us to the same conclusion, namely, they are similar to each other, e.g., the late-phase spectra of V5587 Sgr (shown in Figure 4 in Rosino and Iijima 1987). Figure 5 also shows helium abundances vs t_3 in 20 various novae. Helium abundance of V5587 Sgr seems to be similar to that of PW Vul. This figure indicates that helium abundance is not correlated with t_3.

In summary, we have performed photometric and low-dispersion spectroscopic observations of V5587 Sgr from early to nebula phase. The photometry showed erratic variations of the light curve. The spectra during the early phase showed emission lines of Hα, Hβ, and Fe II (i.e., Fe II type) and V5587 Sgr never showed regrowth of a P-Cygni profile. The nova entered the nebula phase between July 11 to July 29 (t = 158 to 178days). We estimated that the helium abundance of V5587 Sgr is $N(\mathrm{He})/N(\mathrm{H}) = 0.134 \pm 0.09$. The nova is very similar to PW Vul considering decline rates, spectral features, and helium abundance. We obtained a new sample of the "Jitter" class novae.

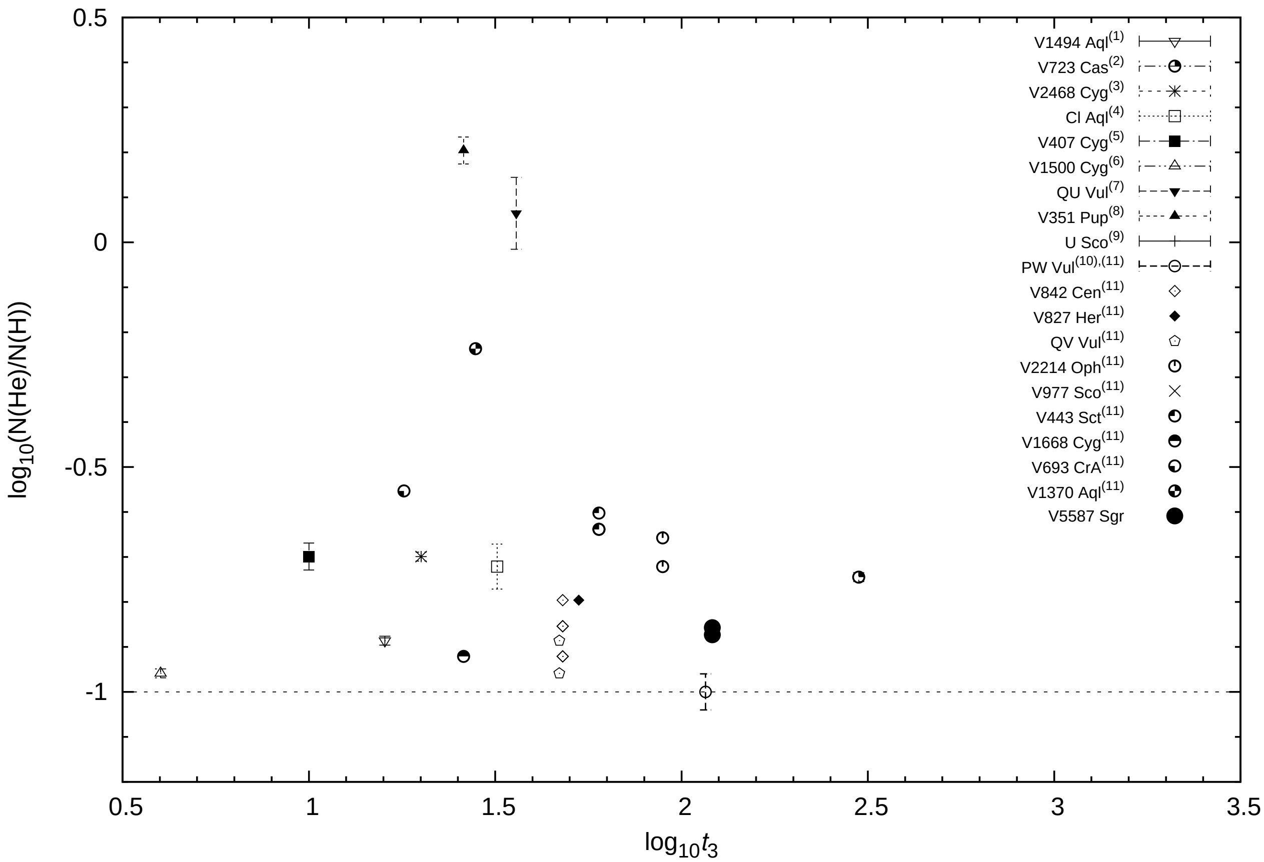

Figure 5: The helium abundance of 20 novae. References: (1) Iijima & Esenoglu (2003); (2) Iijima (2006); (3) Iijima & Naito (2011); (4) Iijima (2012a); (5) Iijima (2012b); (6) Ferland (1978); (7) Schwarz (2002); (8) Saizar (1996); (9) Iijima (2002); (10) Schwarz et al. (1997); (11) Andreä et al. (1994).

References

[1] Andreä, J., Drechsel, H., Starrfield, S.: 1994, A&A 291, 869.

[2] Arai, A.: 2011, IAUC 9196, 2.

[3] Chochol, D., et al.: 2012, MmSAI 83, 767.

[4] Ferland, G.J.: 1978, ApJ 219, 589. doi:10.1086/155818

[5] Iijima, T.: 2002, A&A 387,1013.

[6] Iijima, T., Esenoglu, H.H.: 2003, A&A 404, 997.

[7] Iijima, T.: 2006, A&A 451, 563.

[8] Iijima, T., Naito, H.: 2011, A&A 526A, 73.

[9] Iijima, T.: 2012a, MmSAI 83, 835.

[10] Iijima, T.: 2012b, A&A 544A, 26.

[11] Imamura, K.: 2011, IAUC 9196, 2.

[12] Nagashima, M., et al.: 2014, Journal?, in press.

[13] Nakano, S., Nishimura, H., Kiyota, S., Yusa, T.: 2011, IAUC 9196, 1.

[14] Rosino, L., Iijima, T.: 1987, Ap&SS 130, 157. doi:10.1007/BF00654989

[15] Saizar, P., et al.: 1991, ApJ 367,310. doi:10.1086/169630

[16] Saizar, P., et al.: 1996, MNRAS 279, 280. doi:10.1093/mnras/279.1.280

[17] Schwarz, G.J., et al.: 1997, MNRAS 290, 75. doi:10.1093/mnras/290.1.75

[18] Schwarz, G.J.: 2002, ApJ 577, 940. doi:10.1086/342234

[19] Strope, R.J., Schaefer, B.E., Henden, A.A.: 2010, AJ 140, 34.

[20] Tanaka, J., et al.: 2011, PASJ 63, 159.

[21] Tanaka, J., et al.: 2011, PASJ 63, 911.