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The Nova V5584 Sgr: A Short Review

R. Poggiani [1]

[1] *Department of Physics, Università di Pisa*

Corresponding author: rosa.poggiani@df.unipi.it

Abstract

The nova V5584 Sgr was discovered during 2009 October. It has been monitored in different domains of the electromagnetic spectrum: optical, infrared and X-rays. The optical and infrared observations suggest that V5584 Sgr is a Fe II nova that formed dust. No X-ray emission was observed around the time of maximum.

Keywords: cataclysmic variables -novae - optical - spectroscopy - individual: V5584 Sgr.

1 Introduction

Nova Sagittarii No. 4 was discovered by Nishiyama and Kabashima (2009) on 2009 October 26 and later designated V5584 Sgr (Samus, 2009). V5584 Sgr is a classical example of multi-wavelength astrophysics, since it has been observed in different parts of the electromagnetic spectrum: optical, infrared and X-rays. The very early optical spectroscopic observations secured by Kinugasa et al. (2009), Maehara et al. (2009), Fujii (Maehara et al., 2009), Munari et al. (2009) in the optical and by Raj et al. (2009) in the infrared showed that V5584 Sg is a Fe II nova, in the context of the classification by Williams et al. (1991), Williams (1992). Spectra secured by Russell et al. (2010) during 2010 February showed that dust formation had occurred. Poggiani (2011) has monitored V5584 Sgr during the late decline. V5584 has been investigated in the optical domain by the Stony Brook/SMARTS Consortium (Walters et al., 2012). The present paper reviews the history of V5584 Sgr observations.

2 Light Curve

The photometric evolution and the main parameters of V5584 Sgr has been reported by Poggiani (2011) and will be briefly summarized below for completeness. The V band light curve is reported in Fig. 1. The epoch of maximum is MJD=55134.208 (2009 October 29), while the decline time by two magnitudes is 27±2 days, making V5584 Sgr a moderately fast nova, according to the classification by Payne-Gaposchkin (1957). The reddening of V5584 Sgr is 0.82±0.12. The estimated distance of V5584 Sgr is in the interval 5.8-7.1 kpc. The absolute magnitude at maximum is in the range -7.2....-7.7, while the white dwarf mass is in the range 0.8-0.9 $M_{\odot}$. All parameters extracted by the analysis of the light curve suggest that V5584 Sgr is a Fe II nova, according to the classification by Della Valle & Livio (1998). The spectroscopic observations described below will provide further evidence for the classification.

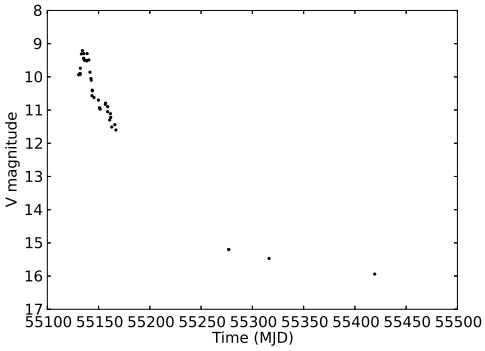

Figure 1: V band photometry of V5584 Sgr

3 Optical Spectroscopy

Spectroscopic observations of V5584 Sgr around maximum have been secured by different authors. Kinugasa et al. (2009) observed Hα and Fe II lines in emission with P Cyg profiles on 2009 October 27. The presence of Hα in emission was confirmed by Maehara et al. (2009) on the same day. Munari et al. (2009) observed a highly reddened absorption continuum on October 28, with Hα and Fe II showing an emission component and the same continuum with faint emission from Balmer ad Fe II multiplets on October 29. It was suggested that V5584 Sgr was a Fe II nova caught around maximum, according to the classification by Williams et al. (1991), Williams (1992). V5584 Sgr has also been observed at the Higashi-Hiroshima Observatory with the

Kanata Telescope (Uemura, 2009) on October 31 and November 3, 5 [1]. The intensity of emission lines progressively strengthened, while the continuum decayed. V5584 Sgr is part of the Stony Brook SMARTS Spectral Atlas of Southern Novae that includes data of more than sixty novae (Walters et al., 2012). Their observations of V5584 Sgr on November 11 showed Balmer lines, Fe II multiplets and O I.

Poggiani (2011) has observed V5584 Sgr during the late decline (after the seasonal gap) at the Loiano Observatory, Italy, using the 152 cm telescope and the BFOSC imager and spectrograph. The observation of June 4 is reported in Fig. 2. The spectrum has been secured using grism #4 that has a range 4000 to 8500 Å and a resolution of 3.97 Å/pixel, reduced with bias and flat frames, extracted using the optimal extraction method by Horne (1986), calibrated in wavelength with an HeAr lamp and corrected with the instrumental response. The spectrum shows a prominent Hα transition, intense forbidden lines of [O III], [N II] and the high ionization line [Fe VII] 6087, typical of a nova in the nebular stage A_0 (Williams et al., 1991; Williams 1992). The same pattern of lines has been observed by the SMARTS Consortium on October 17.

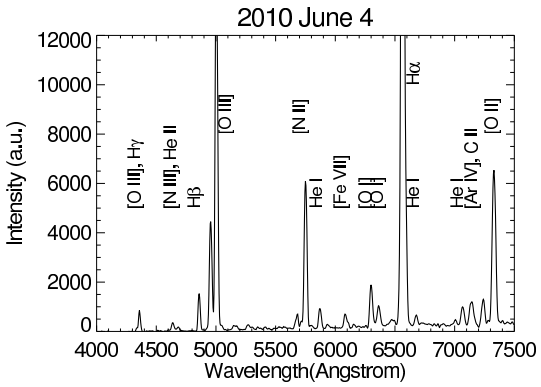

Figure 2: Optical spectrum of V5584 Sgr during the nebular stage (Poggiani, 2011)

The line profiles are a signature of the ejecta distribution. Optically thin winds and optically thin shells show rounded and rectangular line profiles, respectively. The profile of Hα at two epochs (labelled with the number of days elapsed from maximum) is reported in Fig. 3 (Poggiani (2011)). The profiles show a red wing, probably explained by the emerging of [N II] 6584. The rest wavelength is coincident with the 0 km/s label.

The observations of V5584 Sgr during the nebular stage are part of a monitoring program (Poggiani, 2012) active since 2005 at the Loiano Observatory, Italy, using the 152 cm telescope and the BFOSC imager and spectrograph. The most part of the spectra are secured with grism #4 to build an homogeneous data set of spectra over the range 4000 to 8500 Å. The monitoring aims to build a spectral atlas and includes most novae observable at the telescope latitude that underwent outburst after 2005. Other sources are V1663 Aql, V1722 Aql, V2362 Cyg, V2467 Cyg, V2468 Cyg, V2491 Cyg, V407 Cyg, KT Eri, V959 Mon, V2670 Oph, V496 Sct, V5558 Sgr, V458 Vul, V459 Vul. The novae are observed at several epochs, from the early decline to the nebular stage and on the way to quiescence.

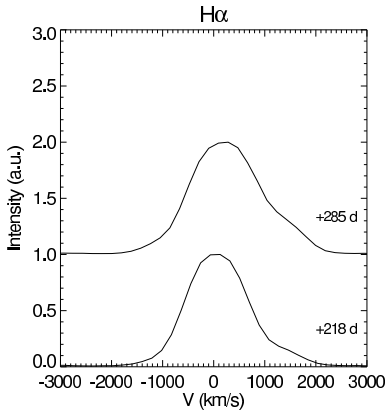

Figure 3: Line profiles of Hα during the nebular stage (Poggiani, 2011)

The importance of monitoring of novae over long time intervals has been addressed by several contributors at this conference (Pagnotta, 2013), (Ederoclite, 2013), (Tappert, 2013). At the moment of writing V5584 Sgr is very far from quiescence. At the moment of discovery, Corelli (2009) showed that nothing was visible at the nova position on a Palomar plate with limiting magnitude 21.

4 Infrared Observations

The relevance of observations of novae in the infrared has been discussed by Banerjee and Ashok (2012) and by Chesneau and Banerjee (2012). Banerjee and Ashok (2012) suggest that the Fe II and He/N classes share a set of common spectral lines in the near infrared, namely hydrogen, helium, nitrogen and oxygen. On the other hand, there is a clear signature belonging only to novae of Fe II class, the presence of strong carbon lines: thus the near infrared observations can provide an additional suggestion of the spectroscopic class of a nova. Several novae, mostly novae belonging to Fe II class, produce dust during the decline. The dust presence is marked by a rise of infrared emission and can become apparent also as a dip in the optical light curve. The last signature is not necessarily observed, since dust can be arranged as an optically thin shell.

[1] http://f.hatena.ne.jp/kanataobslog/20091106162703

Infrared observations of V5584 Sgr have been secured by Raj et al. (2009) on October 29 at Mt. Abu telescope showed Paschen, Brackett, O I, C I, N I lines with P Cyg profiles, whose components wew separated by about 550-650 km/s. The emission components strengthened, while the absorption components faded by November 3. The transitions observed in spectra are typical of the Fe II class novae, providing an independent confirmation of the classification of V5584 Sgr. The following observations in the infrared were secured after the seasonal gap. On 2010 February 10 Russell et al. (2010) observed V5584 Sgr in the region 3-14 μm with AEOS telescope, discovering that the nova had formed dust since the previous observations. The infrared continuum was dominated by the thermal emission of the dust at a temperature of 880±50 K; no details of the dust composition or the derivation of the temperature are reported. The above infrared observatons provide a clue that was not available due to the lack of observations during the seasonal gap.

5 X-Ray Observations

The importance of X-ray observations of novae has been addressed by several authors, also at this conference (Ness, 2013), (Orio, 2013). V5584 Sgr has been observed with the Monitor of All-Sky X-ray Image (MAXI) (Shimanoe et al., 2010). The system is on board of ISS and uses two high sensitivity X-ray detectors, the Gas Slit Camera (32 CCD chips) and the Solid State Slit Camera (a Xenon filled proportional conunter). MAXI scans all sky every 92 minutes. Shimanoe et al. (2010) have searched the prompt X-ray emission at the ignition of the thermonuclear runaway. The authors suggested that classical novae could emit X-rays at the outburst in analogy to the type I X-ray bursts of X-ray binaries. The observations included several peculiar novae: V1723 Aql, V407 Cyg, V2673 and V2674 Oph, V1722 Aql, KT Eri, V496 Sct. The authors have focused on the archive data in the energy band 1.5-4 keV, the lowest energy available, assuming that nova outbursts preferentially emit soft X-rays. They also investigated the 4-10 keV and 10-20 keV bands. No prompt emission was detected in the three bands for any nova. There are no reported X-ray observations of V5584 Sgr at later stages, when supersoft emission could have occurred.

6 Conclusions

V5584 Sgr is a standard Fe II nova. The sinergy of observations in different domains allowed a classification of the spectral class and the discovery of dust production during the seasonal gap.

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DISCUSSION

MARTIN HENZE: You described X-ray observations and mentioned soft band of 1.5-4 keV in which soft X-rays would be expected. I just wanted to comment that in this band we would not expect to see super-soft X-ray emission which normally does not go above 1 keV.

ROSA POGGIANI: The MAXI astronomers stated that they were looking for soft X-ray emission in the above energy range. I agree that to detect the X-ray emission you are mentioning you should use another instrument

JAN-UWE NESS: The MAXI collaboration was looking for prompt emission.