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Near-infrared spectroscopy of Nova Sagittarii 2001 (V4643 Sgr)

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Abstract. Near-infrared spectra of the very fast He/N-type nova, Nova Sagittarii 2001 (V4643 Sgr) obtained in the early decline phase and the period 110 to 170 days after the discovery date are presented. The spectrum in the early decline phase is dominated by emission lines of hydrogen and accompanied by fluorescence excited O I line at 1.129 μm. These lines have broad symmetric emission wings with full width at zero intensity (FWZI) corresponding to a velocity of $\sim$ 10,000 km s^{-1}. About 120 days after the discovery the K band spectrum is dominated by emission lines due to Si VI and Si VII at 1.963 μm and 2.476 μm indicating that the nova had entered the coronal phase. The line ratios of Brackett series deviate substantially from case B values indicating optical depth effects.

1. Introduction

Nova Sagittarii 2001 (V4643 Sgr) was discovered by Liller (2001) on 2001 February 24.369 UT when it was at a magnitude of 7.7. Early optical spectroscopic observations (Della Valle et al., 2001) indicate that the nova was discovered close to its maximum light. The absence of Fe II lines and large velocity of Hα, FWZI (full width at zero intensity) velocity $\sim$ 10,000 km s^{-1}, indicate that V4643 Sgr belongs to the "He/N" class of novae as per the classification scheme of Williams (1992).

V4643 Sgr is an exceedingly fast nova (Bruch 2001) with t_2, the time taken by V magnitude to decline by 2 magnitudes = 4.8 days.

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2. Observations

The JHK spectra of V4643 Sgr in its early decline phase (March 2001) were obtained at the 1.2 m telescope at Mt. Abu observatory using PRLNIC/Spectrometer with a 256 × 256 HgCdTe NICMOS3 array. The resolution of the spectrometer is 1000 and spectra in different bands are obtained by rotating the grating. For each position of the grating spectra were taken with the nova placed at two different positions on the slit. The slit width was 2 arcsecond and was oriented in the North-South direction. The integration time for individual spectrum was 120 seconds for J band and 60 seconds for H & K bands. During the months of June and August 2001 the JHK spectra were obtained with the U.K. Infrared Telescope (UKIRT) and Cooled Grating Spectrometer (CGS 4) at Hawaii.

3. Analysis

The spectra were analysed using the IRAF package. The OH airglow lines that register along with the object spectra were used for wavelength calibration. The image pairs were subtracted from each other to remove the dark current of the array. This procedure also removed the sky emission. The standard star spectra were used to derive spectral sensitivity function. The final combined nova spectra were divided by the standard star spectra.

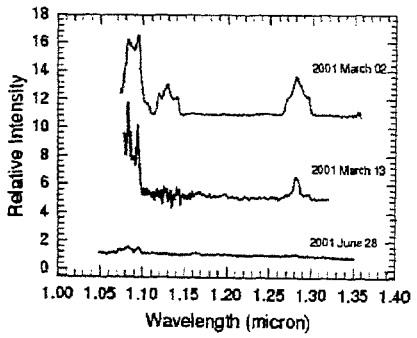

Figure 1. J Band spectra of Nova Sgr 2001

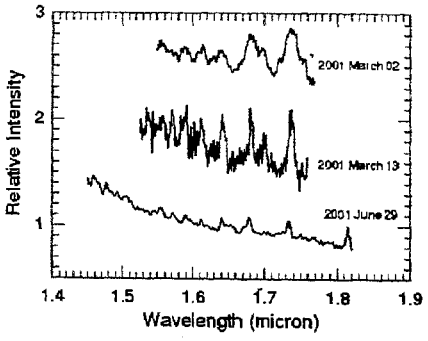

Figure 2. H Band spectra of Nova Sgr 2001

4. Results

Our spectra show several interesting features. One of them is the structural shape of Paschen β (Fig. 1) and Brackett 10 (Fig. 2) hydrogen emission lines which show broad wings and a relatively narrow wine bottle shaped central peak (Ashok et al., 2001a). This

is possibly only the second time that such a shape is seen in IR spectra of a nova. It was earlier seen by Lynch et al., (2000) in the spectra of Nova Ophiuchi 1998. It is also puzzling that while the higher order Brackett series lines (10 to 14) were present in the spectra of March 2 (Fig. 2), Brackett γ was absent (Fig. 3). Interestingly Brackett γ appeared in the spectra taken on March 13 indicating a varying optical depth in the nova ejecta. The O I line at 1.129 μm (Fig. 1), produced by fluorescence mechanism involving excitation by Lyman β photons, mimics the broad shape of H I lines and displays rapid changes. It was strong in the spectra of March 2, but disappeared on March 13, again indicating changes in the optical depth in the nova ejecta.

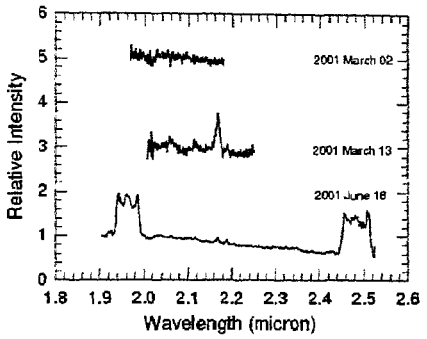

Figure 3. K Band spectra of Nova Sgr 2001

The K band spectrum (Fig. 3) taken on June 16 is dominated by Si VI and Si VII lines at 1.963 μm and 2.476 μm, respectively, indicating that the nova has entered the coronal phase (Ashok et al., 2001b). These lines show multiple components and a large expansion velocity.

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