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OBSERVATIONS OF NOVA CYGNI 1975 AT THE TORUN OBSERVATORY

The spectroscopic observations of Nova Cygni 1975 started at the Torun Observatory on August 29,88 UT immediately after a telephone call from two young Polish discoverers of this star, Baranowski and Garbacz. Between August 29 and October 12, 1975 Prof. Iwanowska, Dr. Burnicki, Mr. Tylenda and ourselves have taken more than 200 spectra of N Cyg with the Canadian Copernicus grating spectrograph attached to the 90 cm Schmidt-Cassegrain telescope of Torun. Their dispersion is 28 A/mm and their spectral range λ 3560-5050 A.

Nova Cygni 1975 is a very unusual nova. The amplitude of its explosion was about 14 mag. The pre-nova is not present on the blue Palomar Sky Survey print having a limiting photographic mag.21, but between August 5 and 13 the visual mag. was about 16 according to the soviet astronomer's observations (IAUC 2826, 2839). The light curve of N Cyg from the photoelectric observations published in IAU Circulars Nos 2826-2849 is shown in Figure 1. It is really a very fast nova: the rate of the decrease of its brightness in the early decline phase was about 1 mag/day. From the rate of decay G. de Vaucouleurs (IAUC 2839) found the absolute visual magnitude at maximum M_V = -10,25 mag. Taking in consideration the absorption from the intensity measurements of the interstellar lines he found for the distance of the Nova the value 1,3 $\pm$ 0,2 kpc.

We have succeeded to make a plot of the colour excesses E_{B-V} against the distance modulus $(V-M_V)$ for about 20 stars found in the Blanco Photometric Catalogue (Blanco et al., 1968) in the field of three degrees in diameter around Nova.

Assuming γ=3,5 in the formula $A_V=\gamma E_{B-V}$, we estimated the interstellar absorption in the direction of Nova ranging from 1,75 to 2,45 mag. For the maximum visual brightness of N Cyg equal 1,8 mag, we obtain a distance of 0,83 to 1,1 kpc with an average value of 1 kpc.

Figure 2 synthetically shows the results of our spectroscopic observations. The first six weeks of the spectacular evolution of Nova Cygni are illustrated there by the time dependent set of the microphotometric density tracings. The first spectra taken on the evening of August 29, 1975 revealed only the fine interstellar H and K absorption lines and a very strong continuum. The spectra taken later the same night show the apparition of the hydrogen Balmer lines of P Cygni profile with very shallow absorptions and broad emission components. The intensity of the emission components of these lines was growing from hour to hour while the continuum became weaker. The measurements of the absorption components of four hydrogen lines give us for the expansion velocity of the envelope values going from about 1000 km/s for the first spectra to 2600 km/s for the spectra taken on September 4. These measurements are shown in Figure 3. Owing to the growing intensity of the emission components and the weakening of the continuum further measurements of the radial velocity of the absorption components were practically impossible. The half-width of the emission lines was 3000-3400 km/s.

In this early stage of Nova evolution we were able to distinguish the following strong emissions: the Balmer H I lines from Hβ to H_{10}, H and K lines of Ca II, Fe II lines at λ5018,4924,4296,4233 and 4197 A as well as Fe II λ 4385 A partly blended with Hγ.A very broad emission feature about λ 4570 seems to be a blend of Fe II λ 4630, 4584, 4549 and 4520 A lines.

The lines of ionized iron and calcium have been rapidly growing up in strength to reach their maximum on September 2 followed by a fast decline. This is clearly visible in the Fe II lines λ4179,4233, 4296 A, about λ 4570 A and in the K line of Ca II. The lines Fe II λ 5018 and 4924 A have a slower rate of decline justified by the probable overlapping with the helium lines λ 5015 and 4922 A. The presence of helium emissions at λ3888, 4471 and 4686 A is indeed obvious on our spectra since September 5. The emission K line of Ca II disappeared on September 7 and the Fe II lines seem to disappear on September 9 excepted Fe II λ 4924 A line which was detectable until September 18. The weakening of the continuum and the Fe II and Ca II lines with a simultaneous increasing of the Balmer H I emission lines and an emission feature about λ 4650 are the most striking marks of the evolution of the spectrum of Nova Cygni between Septem-

ber 2 and 10. The feature at λ 4650 A is due to the emission of N III at λ 4641 A (stronger) and H II emission at λ 4686 A (weaker),A contribution of C III λ 4650 A is also possible.

The line of N III appears on September 3-4 and becomes one of the strongest lines in the spectrum on September 10 beside the Balmer lines.

Beginning from September 1, 1975 for Hβ and the next day for the other lines, the emissions reveal a four components structure. The relative intensity of these components varies with the time. Beside the occasional variations in the short time scale systematic variations seem to occur: in the beginning the stronger were the blue components, later the red ones to become equal at the end.Their average radial velocities are the following:

E_1	E_2	E_3	E_4
- 1060	- 540	+ 170	+ 720 km/s

and seem to be rather stable with the time. The early evolution of that structure for the three Balmer lines is shown in Figure 4.

The first feature of the nebular stage of Nova Cygni, the forbidden lines of [O III] λ 5007, 4959, 4363 and [Ne III], λ 3967, 3869 Å appeared about September 8. Their intensities steadily increased until the last day of our observations. A little earlier on the blue wing of Hδ appears the forbidden emission of [S II]. Since about September 10 the forbidden lines of [Ne III] are present. Their intensity is growing so rapidly that, since September 16, the blend of H_8 + He I + [Ne III] at λ3870 A is dominated by [Ne III]. Near the violet end of our spectra at about λ 3750 A, later than September 10, appeared an enhancing bump formed by the forbidden dublet [O II] about λ 3727 A and O III about λ 3760 A with the probable contribution of [Fe VII] λ 3760 A. The intensity of this emission is slowly but steadily growing.

The second half of September till the end of our observations we have noted the presence of the following additional lines: O II λ 4190, CII λ 4267, He I λ 4471 and N III λ 4515 A.

Owing to the very large width of the emissions the continuum can be observed probably only at about λ 4800 A and possibly at λ 3920 A. In the apparently free of emission space between Hδ and Hε, the He I λ 4026 A line is present. The intensity of Hβ relative to the continuum has reached 2.7 mag on September 4, 1975 and seems to stay at this level till the end of our observations.

Now the Nova Cygni 1975 is too weak (more precisely its continuum is too weak) for our slit spectrograph, so we continue its observations with the help of an objective prism.

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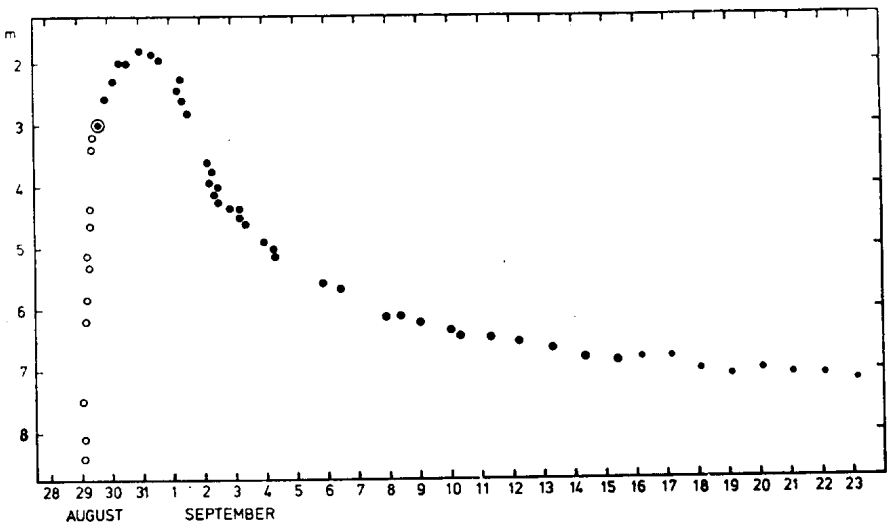

Figure 1. The light curve of N Cygni 1975 based on IAUC 2826-2849. The bigger points - photoelectric V observations;the smaller points (after September 16,1975)-visual observations; the circles - photographic observations of the pre-nova; the point in the circle - discovery observation.

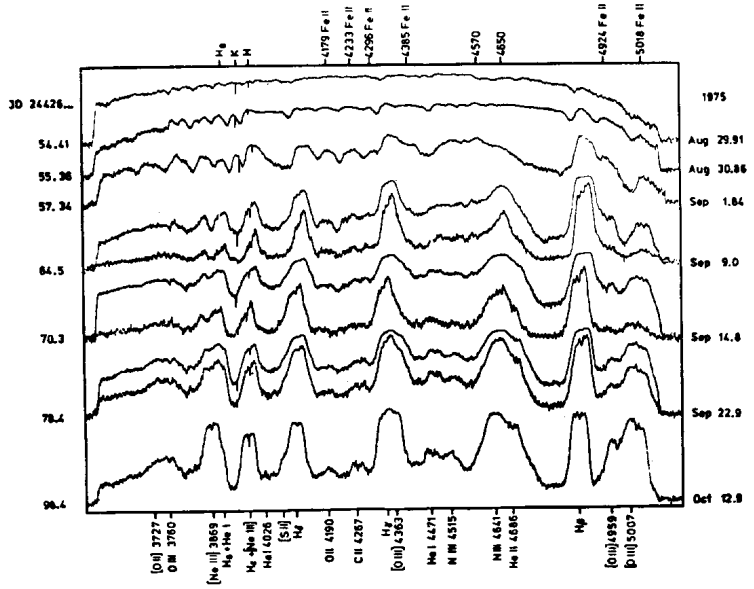

Figure 2. The spectral evolution of N Cygni 1975 from August 29.9 to October 12.9,1975.

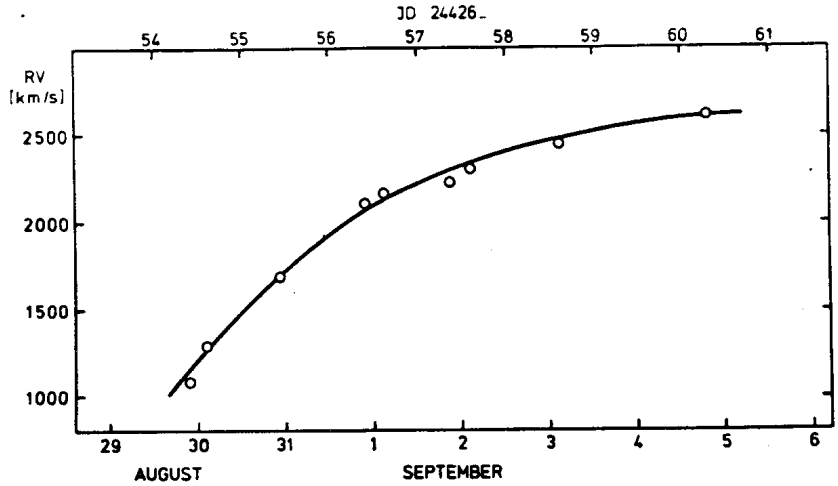

Figure 3. The growth of the envelope expansion velocity in the early stage of the N Cygni evolution.

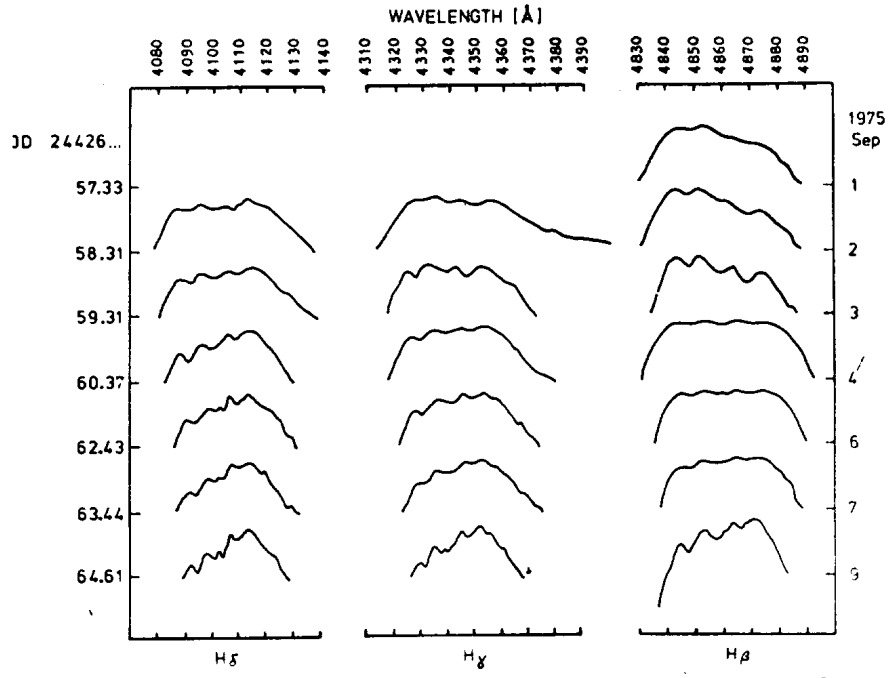

Figure 4. The early evolution of the structure of 3 Balmer emission lines of N Cygni 1975.