SPECTROPHOTOMETRY OF NOVA CORONAE AUSTRINAE, 1981

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Abstract. Spectrophotometric observations of Nova Coronae Austrinae 1981, during its nebular phase are reported. The various emission lines are identified. The electron densities and the mass of the ionized hydrogen in the shell have been calculated. The excess flux in the red continuum probably indicates the appearance of the dust component.

1. Introduction

Nova Coronae Austrinae 1981 (α: $18^h38^m33^s.6$ and δ: $-37°34'09''$ equinox 1950.0) was discovered by Honda as a 7th magnitude object on 2 April, 1981. Figure 1 shows the light curve based on the observations of Caldwell (1981), supplemented by data from IAU Circulars, AAVSO, and our visual estimates. Its rapid decline of about 3 mag. in 12 days places this nova in the category of fast Novae.

In this paper we report the low resolution spectrophotometric observations of the nova obtained during April–June 1981. When these observations commenced the Nova had already entered the nebular phase.

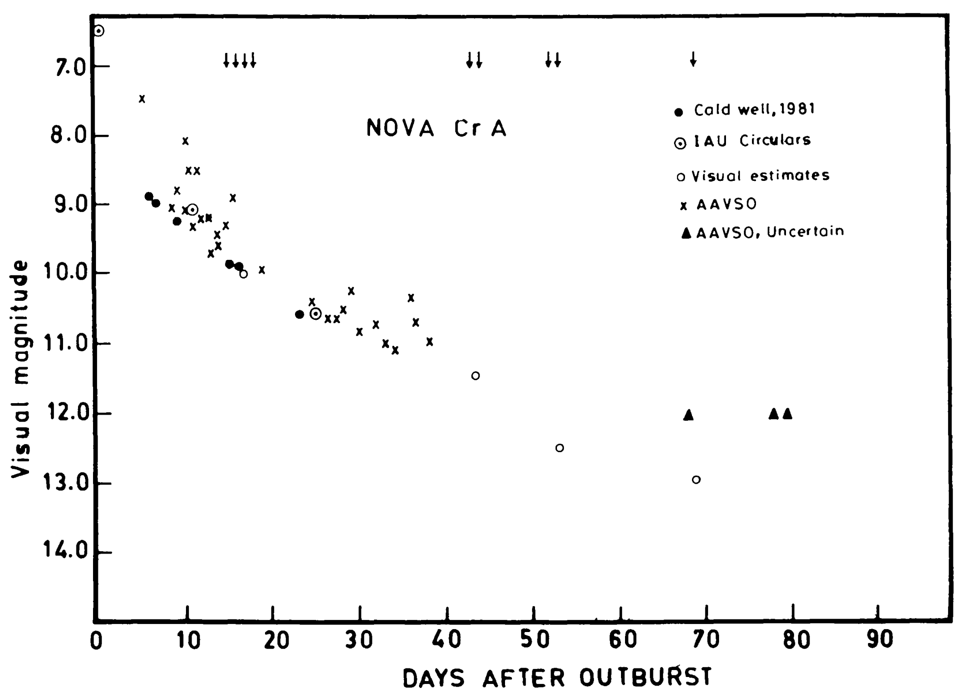

Fig. 1. The light curve of Nova Coronae Austrinae, 1981. The dots are from Caldwell (1981), crosses from AAVSO, unfilled circles are our visual estimates. The arrows in the top represent the time of scanner observations, reported in this paper.

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2. Observations

The observations were obtained with the 102 cm telescope of Kavalur Observatory using the automated spectrum scanner (Bappu, 1977). An exit slot of 20 Å and a channel spacing of 10 Å were used. Initially (April, 1981) the energy distribution in the wavelength range of 4000–6000 Å was obtained with a refrigerated EMI 9804B

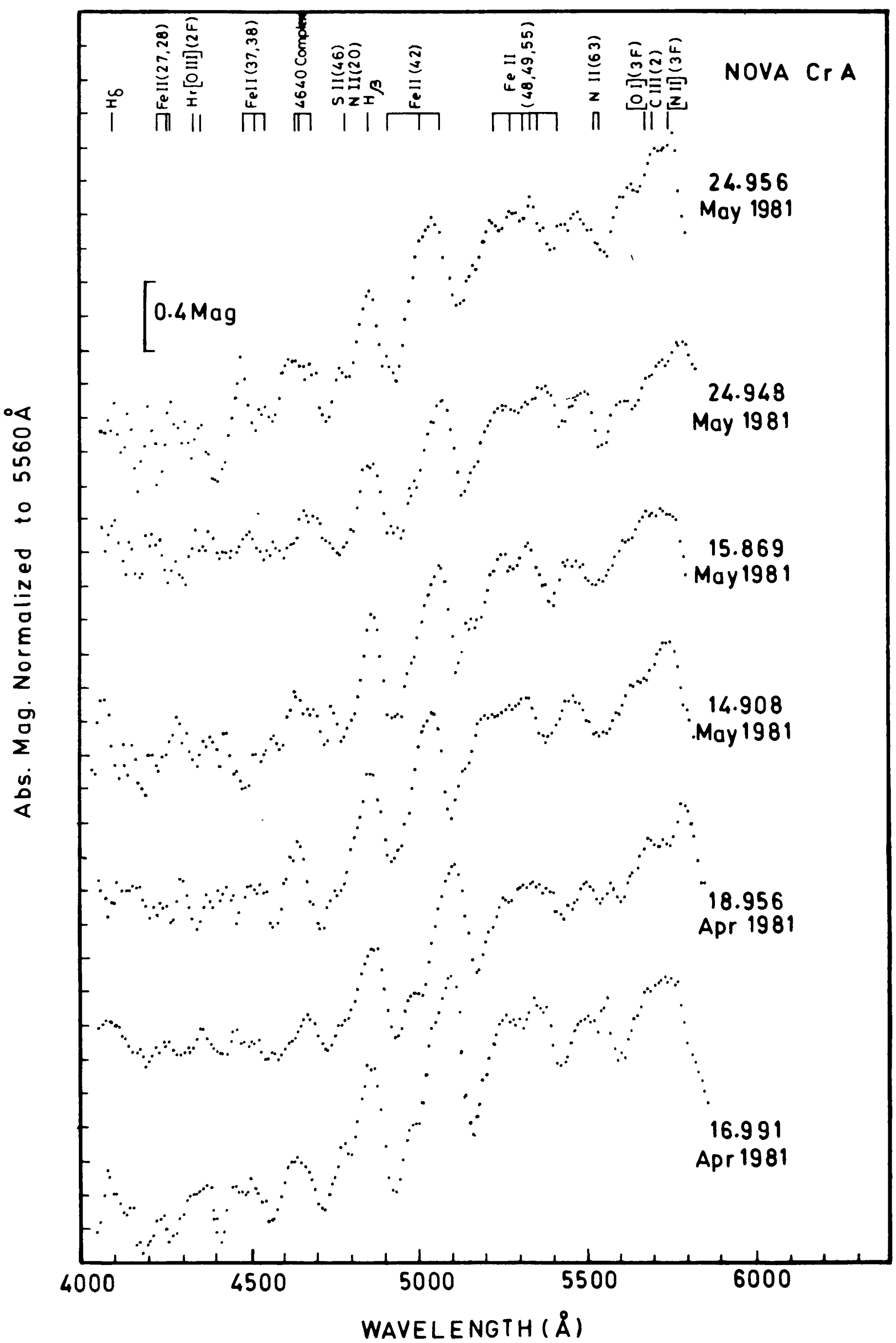

Fig. 2. The development of the blue spectra of Nova Coronae Austrinae 1981. Various emissions are identified with multiplet numbers.

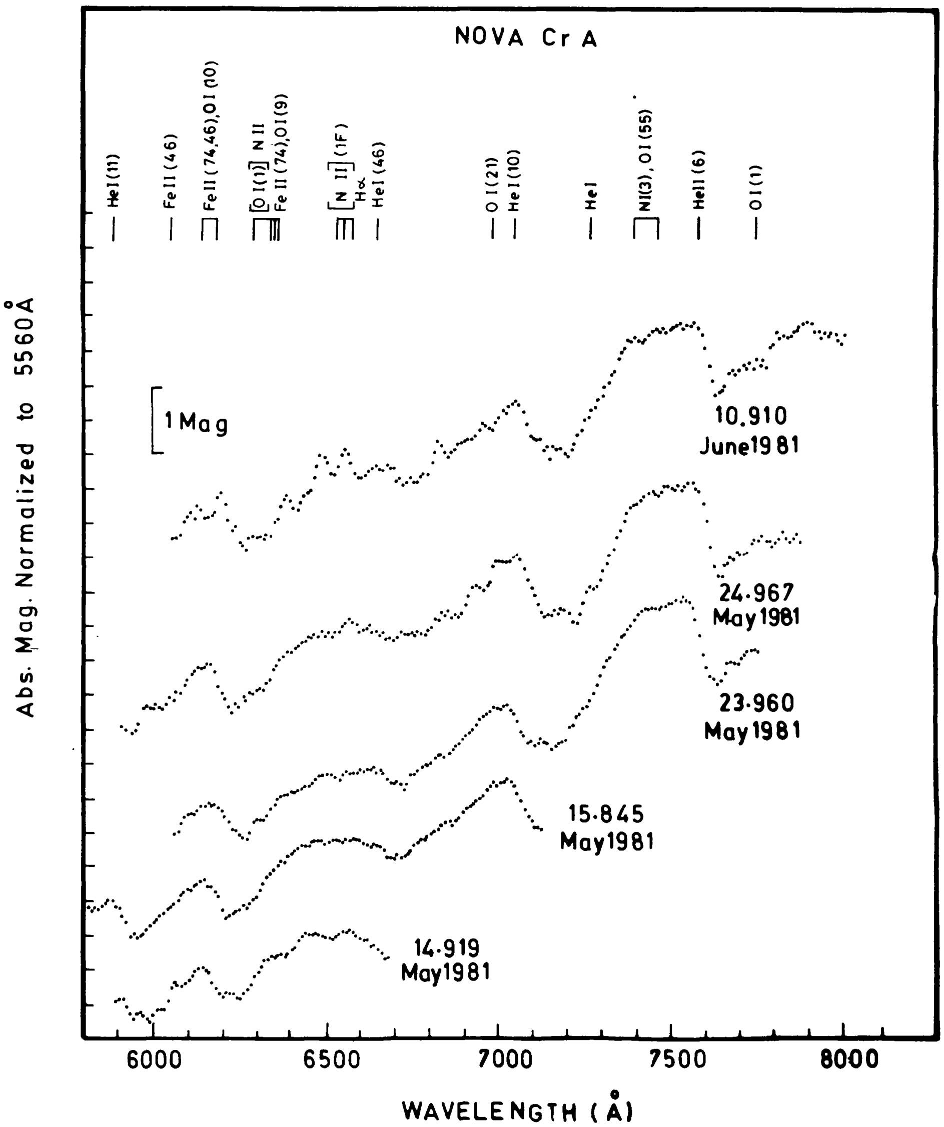

Fig. 3. The red spectra of the Nova. Possible emissions are indicated with multiplet numbers.

photomultiplier. For later observations (May and June, 1981) the wavelength range was extended to ~ 8000 Å with a refrigerated EMI 9558B tube. Each scan was corrected for instrumental sensitivity using a few standard stars (Breger, 1976) observed on the same night. All the scans were normalized at 5560 Å.

The scans were generally noisy because of the intrinsic faintness of the Nova (> 10 mag.) as well as the large airmass through which the observations were obtained. To improve the signal-to-noise ratio, three-point averaging was done for all the scans. The final spectra are represented in Figures 2 (blue region) and 3 (red region).

3. Description of the Results

The spectra are dominated by several emission features which are blended. Some of these features are described below. Hδ is recognizable in spite of the noisy continuum. The emissions near λ4250 is probably a blend of Fe II (27) at 4233 Å and 4273 Å, Fe II (28) at 4258 Å. Hγ at 4340 Å can be recognized and seems to be blended with [O III] (2F) at 4363 Å. The broad emission feature near λ4500, might have contributions from Fe II (37) at 4489 Å and 4491 Å, Fe II (38) at λ4523, 4550 Å, and several lines of O II (86). To the λ4640 feature the probable contributors are N III (2) at 4642 Å, C III (1) at 4650 Å and He II (1) at 4686 Å. The feature at λ4790 may be S II (46) or N II (20). The broad feature near λ5060 consists of [O III] (1F) at 4959 Å and 5006 Å and Fe II (42) at 4924 Å, 5018 Å, and 5169 Å. There seems to be many more blended emissions upto 5900 Å, some of which are indicated in the figure.

The red spectra are also dominated by emission lines. The peak at 5890 Å is probably due to He I at λ5876 Å. The emission feature at about 6060 Å consists of Fe II (46) at λ6045, 6086, 6185 Å along with Fe II (74) at λ6150, O I (10) λ6158. The emissions at λ6560 Å might consist of [O I] (1F) at 6300 and 6364 Å, Fe II (74) at 6456 Å, [N II] (1F) at 6548 Å, in addition to Hα. He I (46) λ6678 Å might be a contributor to the red wing of λ6560 feature. The next emission blend at λ7060 consists of He I (10) λ7065 and O I (21) λ7002. Indications of the presence of O I (1) at λ7772–6 can be inferred on the spectra of 24 May and 10 June.

4. Discussion

There appear to be few spectroscopic observations of this nova. Brosch (1982) obtained a spectrophotometric scan on 10 April, corresponding to the 'Orion' phase. He has identified several forbidden lines. A comparison of our observations (although the resolution is poor) with his scan, show several further developments in the emission spectrum. The strengthening of the λ4640 complex during April and May is recognizable.

The red scans show more flux in the continuum. The scan obtained by Brosch (1982) shows a flat continuum. On 27 April, Vrba (IAU Circ., No. 3604) apparently matched the energy distribution from 0.36μ to 2.5μ, with that of a 5700 K black-body. No IR emission attributed to a dust component has been detected. All the red spectra, presented here, are obtained at least 17 days later; they show excess flux in the longer wavelength regions.

Moderately fast novae like nova Cygni 1978, showed enhanced IR emission after about 35 days of outburst (Gehrz *et al.*, 1980). Since this Nova Coronae Austrinae 1981, comes under the category of fast novae, similar to Nova Cygni 1978, it is expected to show enhanced IR emission at the corresponding phase. Thus it is likely that the excess flux in the red region is due to the appearance of IR emission. A 1000 K black-body distribution (normalized at 6000 Å) matches the red continuum as shown in Figure 4. This probably indicates the appearance of the

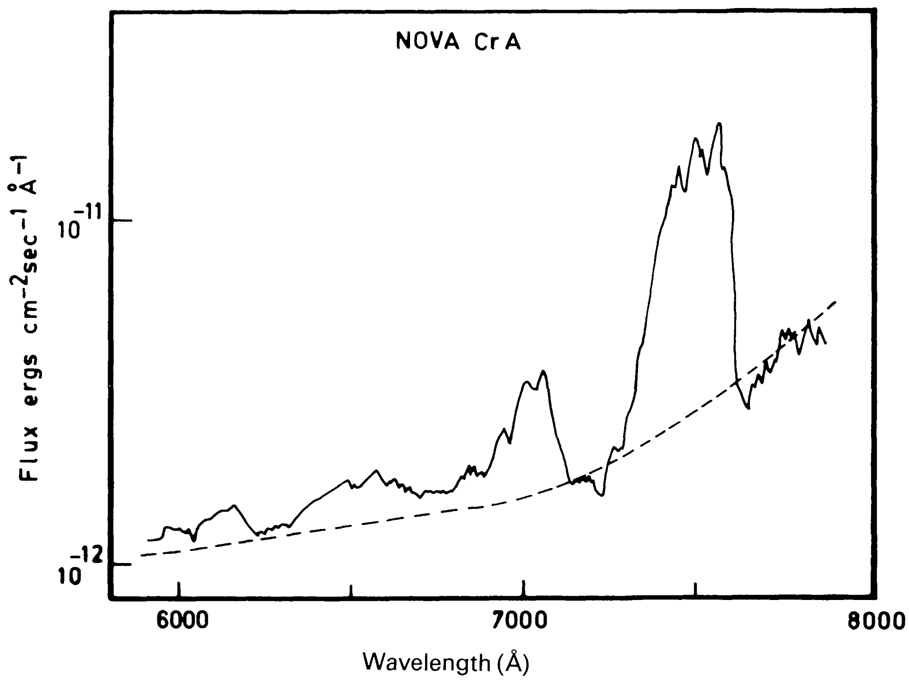

Fig. 4. The red spectra of May 24.956 in absolute flux units. A 1000 K black-body distribution (normalised at 6000 Å) also is shown.

expected dust component. It is assumed, following Stickland *et al.* (1981) for Nova Cygni 1978, that the dust does not form a shell, which is optically thick at optical wavelengths.

The fluxes at Hβ were measured, assuming that the feature at λ4860 is contributed by only Hβ. They were corrected for reddening of $E\ (B-V) = 0.56$ following Brosch (1982). The ratio of the selective to total absorption was taken to be 3.0. The electron density is estimated from the corrected Hβ flux (cf. Malakpur, 1973)

$$N_e^2 = \frac{4\pi F_{\mathrm{H}\beta} r^2}{\varepsilon_{\mathrm{H}\beta} V}, \tag{1}$$

where r is the distance of the nova, $\varepsilon_{\mathrm{H}\beta}$ is the emissivity, and V is the volume of the shell.

While Brosch (1982) estimates a distance of 11.5 kpc to the Nova, Caldwell's (1981) estimate is 9 kpc. We have used both these estimates in our calculations. If we assume $T_e = 10^4$ K, $\varepsilon_{\mathrm{H}\beta}$ is taken as 1.22×10^{-25} ergs cm^{-3} s^{-1}. The volume of the shell is calculated assuming that it expands uniformly with a velocity of 4500 km s^{-1}. The thickness of the shell is calculated, following Pottasch (1959) as

$$\Delta R = 3at, \tag{2}$$

where $a = 10^6$ km s^{-1}.

Thus the electron densities and, hence, the mass of the ionized hydrogen in the shell (assuming that there are 1.4 electrons per hydrogen atom) were calculated and are listed in Table I.

TABLE I

The corrected Hβ fluxes electron densities and mass of the ionized-hydrogen in the shell

Date	Flux at Hβ	$r = 11.5$ kpc		$r = 9.0$ kpc	
	(ergs $cm^{-2}\,s^{-1}$)	$N_e(cm^{-3})$	$M_s/M_\odot$	$N_e(cm^{-3})$	$M_s/M_\odot$
April 16.991	1.1×10^{-9}	1.0×10^{10}	8.2×10^{-4}	7.9×10^{9}	6.4×10^{-4}
April 17.994	9.5×10^{-10}	1.1×10^{10}	8.9×10^{-4}	8.6×10^{9}	7.0×10^{-4}
April 18.956	3.8×10^{-10}	1.6×10^{10}	1.9×10^{-3}	1.2×10^{10}	1.5×10^{-3}
April 19.994	3.2×10^{-10}	4.1×10^{9}	6.0×10^{-4}	3.2×10^{9}	4.6×10^{-4}
May 14.908	3.6×10^{-10}	1.1×10^{9}	2.5×10^{-3}	8.8×10^{8}	1.9×10^{-3}
May 15.869	1.6×10^{-10}	7.2×10^{8}	1.7×10^{-3}	5.6×10^{8}	1.3×10^{-3}
May 23.948	2.8×10^{-10}	7.3×10^{8}	3.0×10^{-3}	5.7×10^{8}	2.4×10^{-3}
May 24.956	2.1×10^{-10}	6.2×10^{8}	2.6×10^{-3}	4.9×10^{8}	2.0×10^{-3}
June 10.910	1.5×10^{-10}	3.4×10^{8}	5.6×10^{-3}	2.7×10^{8}	4.4×10^{-3}

5. Conclusions

The spectrum of Nova Coronae Austrinae 1981, compares well with the nebular phase of a typical fast Nova. The electron density and the mass of the ionized hydrogen also agree well with that of a typical Nova. There appears to be excess flux in the red continuum, which matches with that of a 1000 K black body. This possibly indicates the appearance of a dust component.

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