ULTRAVIOLET PHOTOMETRY OF NOVA SERPENTIS 1970

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I. INTRODUCTION

The appearance of the bright nova, Nova Serpentis 1970, provided the first opportunity to obtain spectrophotometric observations of a nova in the vacuum ultraviolet. OAO-2 carried out systematic measurements from shortly after outburst on through the first sixty days of nova activity. This data consists of filter photometry and spectral scans utilizing the Wisconsin instrumentation described by Code et al. (1970). It is the purpose of this paper to describe general characteristics of the light and spectral variations in the ultraviolet exhibited by this set of data.

II. OBSERVATIONS

Nova Serpentis 1970 was discovered on February 13, 1970 by M. Honda (Hirose 1970). The first attempt to observe the object by the OAO occurred on February 17 with negative results. Dr. C. M. Anderson obtained a photograph position of Nova Serpentis with the 36-inch Pine Bluff reflector on the night of February 18. On the basis of this revised position, OAO-2 obtained the first measurements of a nova in the ultraviolet on February 18.5008, 1970 (JD 2440636.008). Reliable photometry was obtained for all filter bandpasses longward of 1500 Å. A spectral scan with the long wavelength spectrometer provided data with a resolution of approximately 20 Å longward of 2500 Å. The spectrum displayed absorption lines similar to those characteristic of an early F star, although the energy gradient was steeper, suggesting significant interstellar extinction. Throughout the following two months of observations the radiation shortward of 3000 Å gradually increased in intensity while the spectral scans were characterized by a complex development of emission line features. Thus while the visual light curve declined 2.5 magnitudes the flux at 2460 Å, for example, increased by approximately 2.5 magnitudes.

Figure 1 shows three representative spectral scans obtained with Spectrometer 1 on February 20, March 9 and April 4, 1970. At the spectral resolution of 20 Å, the emission features first made their appearance about six days after discovery. Most of the features have not as yet been identified and are probably blends of several strong lines. Two of the features have been tentatively attributed to Fe II emission while the strong line at 2800 Å is the Mg II resonance doublet. During the period covered by these spectra, the visual magnitude decreased by about 2.5 magnitudes. It is apparent from examination of the spectra presented that the flux at the long wavelength limit of the scan is decreasing while both the underlying continuum and the broad emission features shortward of 3200 Å continued to brighten. In the final spectra on April 4, the Mg II emission line at 2800 Å dominates the spectrum.

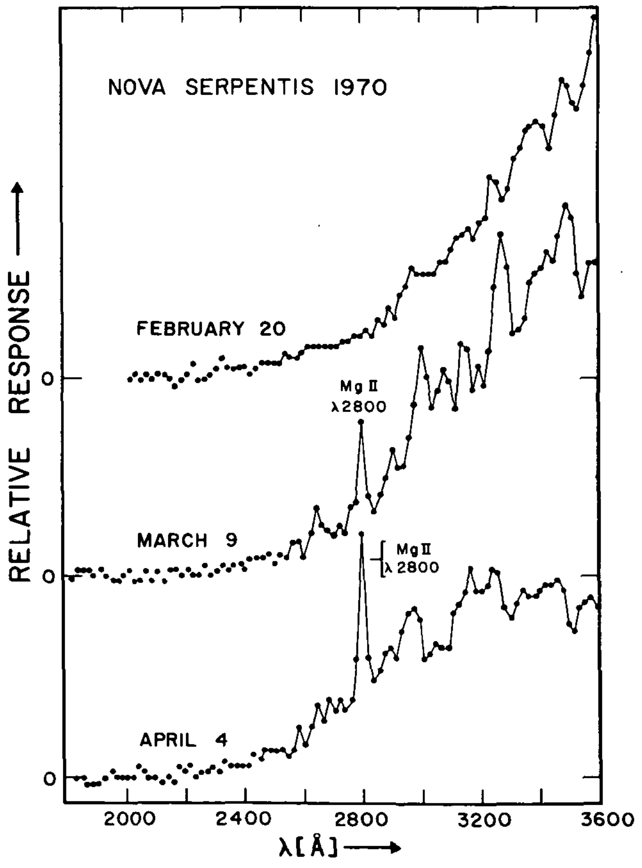

Figure 1.

Figure 2a shows the visual light curve during the period of observation based on the data from Borra and Anderson (1970). Figure 2b shows the variation in the continuum adjacent to the 2800 Å emission while in Figure 2c the emission line intensity is plotted. The simplest interpretation of the Mg II resonance line strength is that through the first 50 days we are observing an optically thick shell. On the basis of a constant velocity of expansion of the order of 800 km/sec the observed intensity variation is consistent with a radial expansion accompanied by a decrease in shell temperature from 10000°K to 8000°K. We may estimate the total number of resonance Mg II ions if we assume that the optical depth becomes unity about 50 days after outburst, corresponding to the time when the intensity begins to decrease. The total mass of Mg II under these assumptions is quite small, of the order of 10^{22} grams.

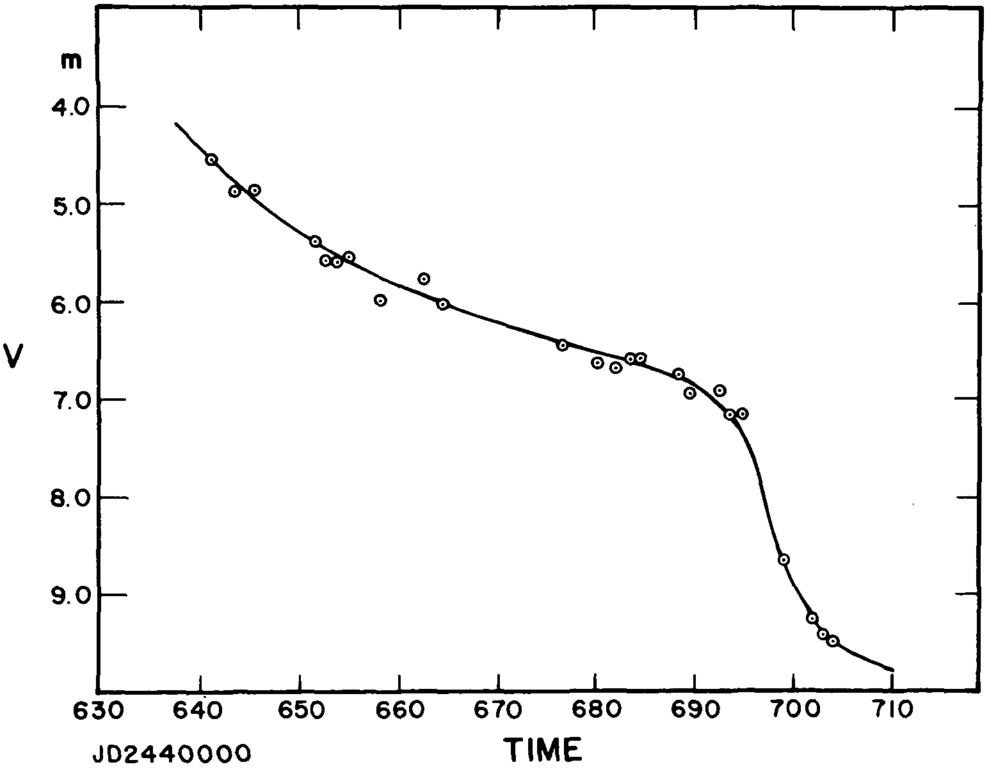

Figure 2a.

The broad band filter photometry exhibits the same property displayed by the spectral scans. The longest wavelength bandpass at 4250 Å yields a light curve similar to the visual curve. The light curve at about 3000 Å increases about 2.5

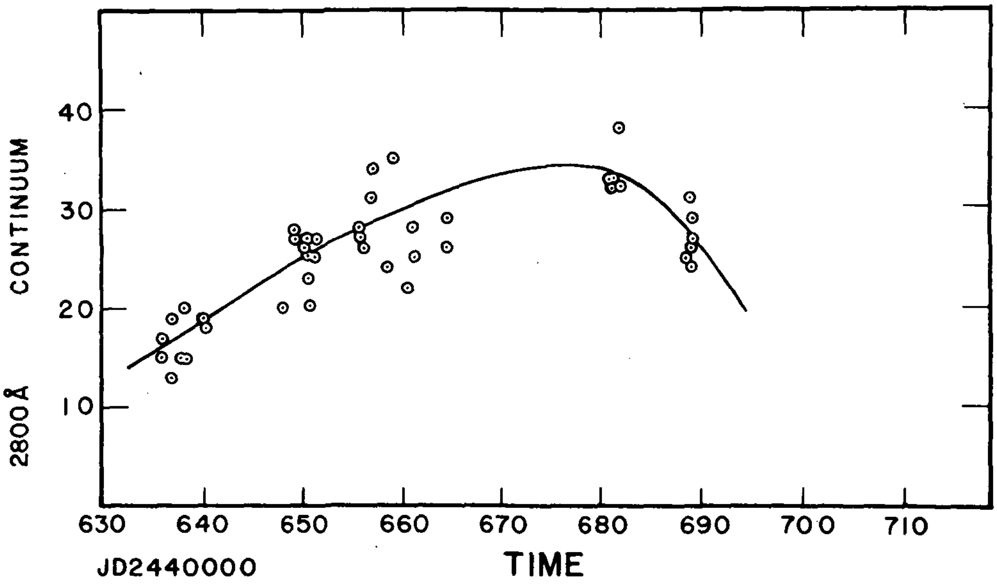

Figure 2b.

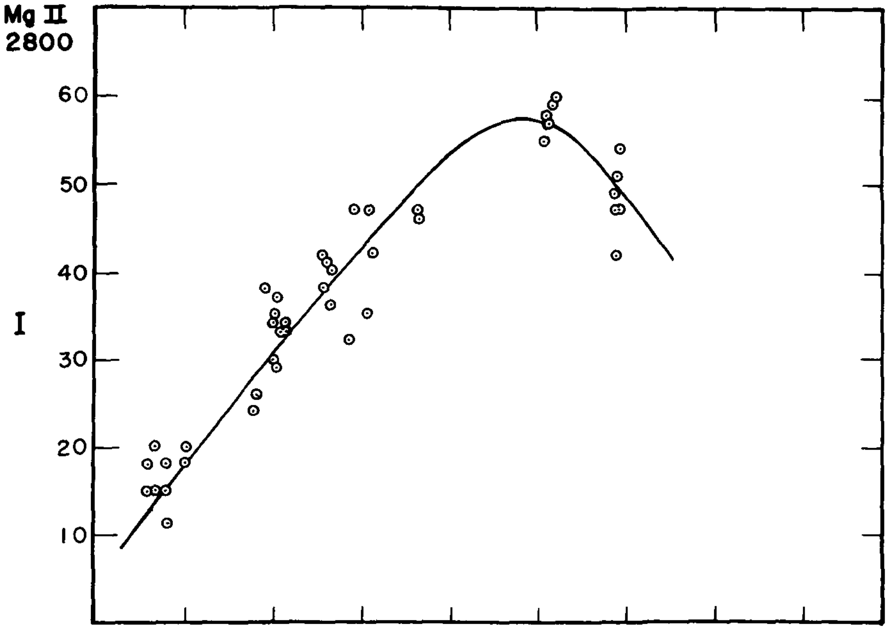

Figure 2c.

magnitudes during the first 25 days and then starts a slow decline throughout the remainder of the observing period. At 2460 Å and 1550 Å the intensity continued to increase during the entire period of observations. The B-V colors of Nova Serpentis, the existence of a very strong diffuse 4430 Å band, and the ultraviolet spectral distribution indicate a B-V color excess of the order of 1 magnitude or a visual extinction $A_V \sim 3.0$ magnitudes. Figure 3 shows the ultraviolet energy distribution derived from filter photometry measurements, assuming the average extinction given by Bless and Savage (1972) for $A_V = 3.0$ magnitudes.

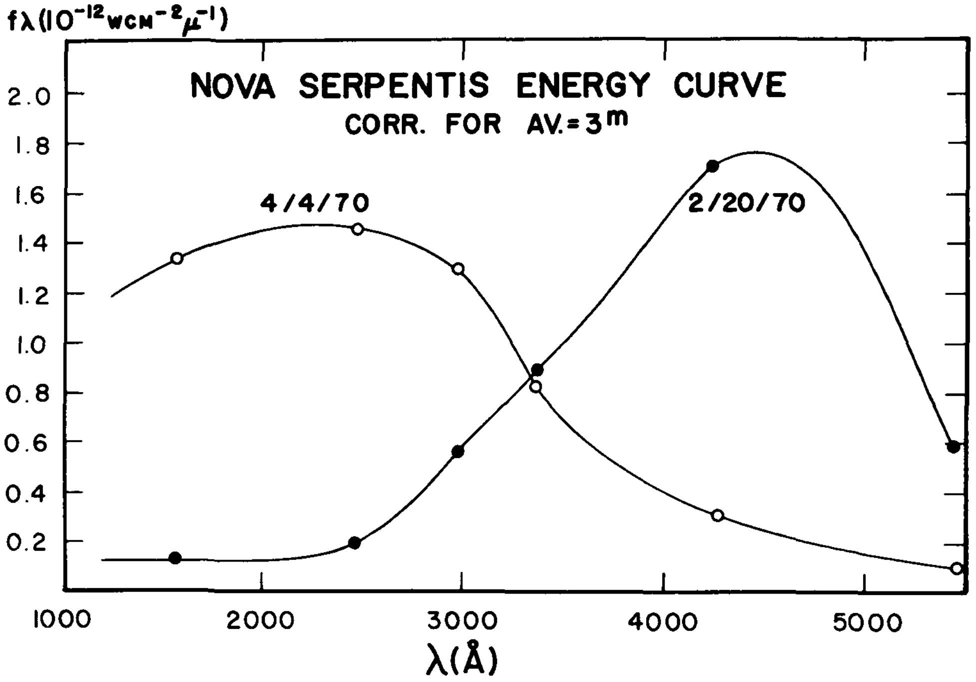

Figure 3.

The ultraviolet energy distribution defined by the filter photometry yields approximately constant total flux between 1000 and 6000 Å during the first 60 days, the decrease in light in the visual being due to a shift of the energy curve towards the ultraviolet as the system evolves. These results suggest a model in which the bolometric luminosity remains relatively constant but the conversion of far ultraviolet photons to longer wavelengths undergoes a secular change as the density of the shell decreases. The system is thus somewhat analogous to the rapid evolution of a planetary nebula.

If the visual extinction suggested by the ultraviolet energy curve and the B-V measurements arises from a nearby dust cloud, the energy absorbed by the grains is more than sufficient to account for the infrared emission commencing 50 days after outburst (Geisel, Kleinman and Low 1970). The infrared radiation at 10 μ reached a maximum about 100 days after outburst at which time it was characterized by a black body temperature of the order of 900°K. Whether or not the ultraviolet radiation absorbed by the grains would raise the temperature to 900°K depends upon the albedo and infrared radiation properties of the grains. Another important input to the grain temperature is the mass motion of the expanding shell. Virtually all hydrogen atoms would be stopped by an optically thick dust cloud. Estimates of the grain heating by atom-grain collisions yield temperatures and infrared emission similar to the observed radiation.

REFERENCES

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