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ULTRAVIOLET OBSERVATIONS OF LMC NOVA 1988

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**ABSTRACT**

This currently bright novae was first detected in outburst on March 21, 1988. Its discovery has given us the opportunity of studying the first extragalactic nova in the ultraviolet and we have, therefore, obtained a number of LWP and SWP spectra when it was at maximum. We have also obtained a high dispersion LWP spectrum in order to study the ISM in the Large Magellanic Cloud on a slightly different line-of-sight from that analyzed using SN 1987A.

**1. Introduction**

Except for a small number of investigations, the studies of novae in external galaxies have been primarily limited to studies of their distribution and light curves. The major studies of the distribution of novae have been done for M31 (Arp 1956; Rosino 1973; Ciardullo *et al.* 1987). The most recent spectroscopic analyses of novae in M31 have been done by Ciardullo, Ford, and Jacoby (1983) and Cowley and Starrfield (1987).

The spectral features seen in the spectra of the four novae studied by Ciardullo, Ford, and Jacoby (1983) and the one slow nova studied by Cowley and Starrfield (1987) appear quite normal. However, in neither study were the novae followed through to the nebular stage of their evolution (when the density of the expanding shell has fallen to where a large number of forbidden lines from highly ionized species are

present) and it is probable, anyway, that they would have been too faint to study when they reached this phase.

We also note that Ciardullo *et al.* (1987) found that the distribution of bulge novae in M31 follows the light from the bulge and only a few novae appear to come from a disk distribution. However, it seems most likely that most of the novae in the solar neighborhood come from a disk population and we are not detecting the bulge novae in our own galaxy.

The theoretical studies of the nova outburst have shown that the observed properties of the explosion depend upon a variety of factors such as white dwarf mass, white dwarf luminosity, mass accretion rate, and the chemical composition of the mixed (accreted material plus core material) envelope (see Starrfield 1987; Starrfield and Sparks 1987; and Shaviv and Starrfield 1987 for recent reviews). While there is no theoretical reason to expect to find fundamental differences between nova outbursts that occur in different stellar populations, it is still important to study novae in as many different environments as possible and either confirm or deny the theoretical investigations.

While the nearest large galaxy to our own is the LMC and it is known to exhibit nova outbursts with a reasonable frequency (Graham 1987; private communication), there have been no detailed optical or ultraviolet studies of novae in this galaxy. Therefore, when a bright nova was recently discovered in the LMC, we

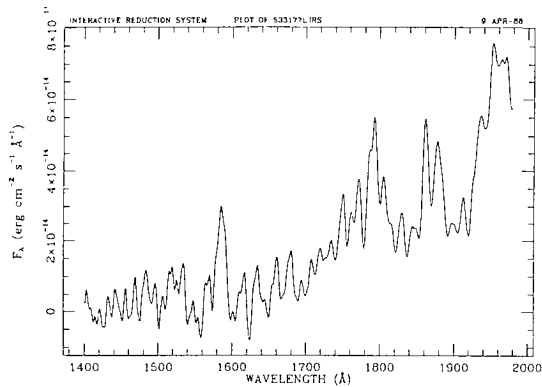


Figure 1a. This 80 minute SWP spectrum was obtained on March 25, 1988. It is a typical spectrum for a nova near maximum.

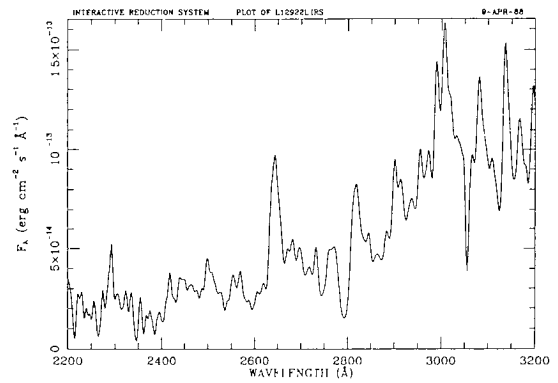


Figure 1b. This 30 minute LWP spectrum was also obtained on March 25, 1988. Note the very deep P-Cygni profile for Mg II 2800Å. The deep depression at 3055Å is a camera artifact.

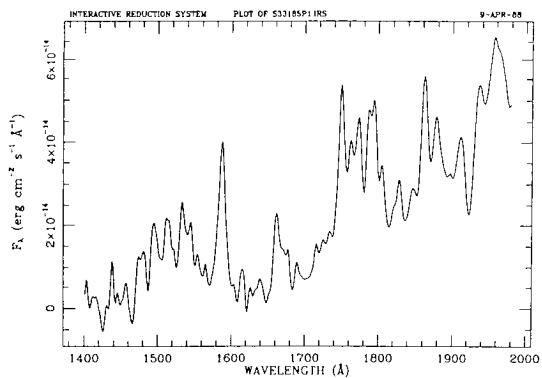


Figure 2a. This is a 160 minute SWP spectrum obtained on March 30, 1988. There are obvious changes over the five day interval.

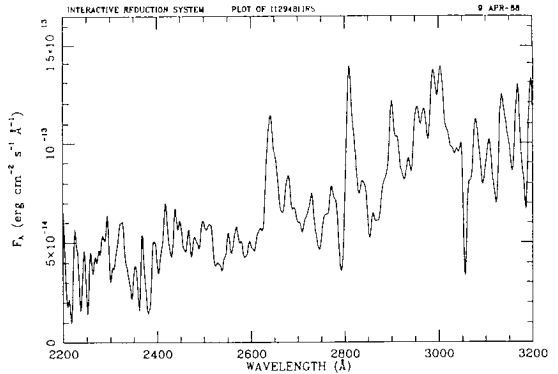


Figure 2b. This is a 15 minute LWP spectrum obtained on March 30, 1988. The flux scaling between this spectrum and Figure 1b are identical in order to emphasize the real changes that have occurred in the spectrum over the 5 day interval.

decided to observe it both optically and with the IUE satellite. In addition, this nova turned out to be bright enough, in the wavelength range of the LWP camera, to enable us to obtain a high dispersion spectrogram by combining USI and Vilspa shifts. Aside from the basic interest in a high dispersion study of novae (Sion *et al.* 1986), this image will allow us to sample the ISM in the LMC on a slightly different line of sight than was analyzed for SN1987A. It might be possible to determine which, if any, of the species found in the SN1987A analysis (Dupree *et al.* 1987) actually came from the circumstellar material surrounding the progenitor and not the general ISM.

## 2. Observations

This nova was discovered by Garradd on March 21.484 1988 UT (IAU Announcement Card #4568). A precise position of  $\alpha = 5^{\text{h}}36^{\text{m}}01.92^{\text{s}}$  and  $\delta = -70^{\circ} 23'15.2''$  (1950.0) was provided by McNaught (IAU Announcement Card #4569). We began obtaining optical spectra at the 1.5-m telescope at the Cerro Tololo Interamerican Observatory and obtained IUE SWP and LWP spectra on March 25, 1988. We were able to obtain more spectra over the next few days and a high dispersion LWP spectrum was obtained on March 30, 1988. These spectra are now undergoing analysis. In this brief report we show only the two best of the SWP and LWP spectra as Figures 1a and 1b and 2a and 2b. The date and exposure times are given in the figure captions. Completely unlike the ultraviolet behavior of Nova Vul 87 (Starrfield *et al.* 1988; these proceedings), this nova still appears to be getting brighter between the first and last of the spectra. In addition, Mg II 2800Å is becoming stronger with time. We were unable to extract and display the high dispersion spectrum before this meeting. If we are able, we shall present plots of that spectrum during the meeting.

We have recently begun a project to perform spectral syntheses of the early spectra of novae (see Stryker *et al.* 1988; these proceedings) and these spectra will be among the first that we analyze.

## 3. Summary

We have obtained the first ultraviolet spectra of a nova in an external galaxy. The spectral features that are seen do not seem unusual for a nova at maximum (see Stryker *et al.* 1988; these proceedings) but we hope to be able to follow it for a long enough time to be able to study the high ionization lines that appear when the density drops to lower values (the nebular stage). We have also obtained a high dispersion spectrum and will use it to assist in the line identification and to study the line of sight to the LMC about one degree of arc away from SN1987A.

## Acknowledgements

This study would not have been possible without the rapid response of the IUE Observatory to our requests for Target-of-Opportunity observations of novae and we are grateful to the IUE observatory for their continued support of nova observations. The data were reduced with the facilities of the RDAF at the University of Colorado which are supported by NASA Grant NASS-28731 and T. Armitage's help is gratefully acknowledged. We also acknowledge partial support for this research from NASA, NSF, and the DOE through grants to our various institutions.

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